SCIENCE ABSTRACTS.

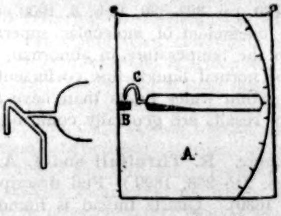
PHYSICS AND ELECTRICAL ENGINEERING.

MAY 1900.

GENERAL PHYSICS.

985. *Hydrometers.* **G. Guglielmo.** (Accad. Lincei Atti, 8. pp. 341–347, Dec. 17, 1899, and 9. pp. 9–12, Jan. 7, 1900.)—Description of areometers with scale and also a series of weights. If the areometer weigh P and the additional weight is P′ while the scale reading is *d*, the true reading is $d(P + P')/P$; and as P′ may be made a tenth, two-tenths, &c., of P, the computation is very simple. Other forms of areometer and also a hydrostatic balance are described. A. D.

986. *Hydrometers of Total Immersion.* **G. Guglielmo.** (Accad. Lincei Atti, 9. pp. 33–41, Jan. 21, and pp. 71–72, Feb. 4, 1900.)—The hydrometers described are totally immersed, thus avoiding any disturbance due to surface tension. One, shown in the figure, is of constant weight but variable inclination, the reading of the density depending on the angle of inclination, whilst the other is of constant inclination but of variable weight, the reading of the density depending on the weight added. In the figure A is the vessel; B is the support of the hydrometer; C and D indicate the way in which the instrument is supported. A. G.



987. *Viscosity of Glass.* **C. Barus.** (Amer. Journ. Sci. 9. pp. 139–142, Feb., 1900.)—If a short thread of mercury is used in water as an index in the vertical stem attached to a glass bulb it is a common observation to find that the mercury will gradually creep downwards into the bulb. The author has been studying this phenomenon since 1896, and the experiments extending from 1896 to 1899 tend to show that the motion is mostly due to viscosity of the glass bulb, a gradual increase in size taking place even under an excess of pressure inside the bulb corresponding to the 2 or 3 cm. column of mercury.

One explanation of the phenomenon is based on the supposition that there is a film of water between the mercury and the glass, and that there is a slow viscous transference of water from one side of the mercury column to the other. Supposing the ordinary laws of viscosity to hold, calculation gives the thickness of this film as much below the diameter of the molecule of water.

Experiments extending over one year were conducted on the rate of fall at practically constant temperature, and also at constantly and definitely varying temperatures, the mercury column rising and falling in the tube at an average rate of about 1 cm. in 10 secs. for 3,000 seconds. Experiments were also made with different sizes of bulbs and stems and different lengths of mercury columns, and the author concludes from the results that there can be no doubt that the cause of motion is the volume viscosity of the bulb. In the case of two different tubes the rates of fall were practically constant for the four years during which the experiments lasted. J. B. H.

988. *Conductivity, Specific Gravity, and Surface Tension of Aqueous Solutions of Potassium Chloride and Sulphate.* **J. Barnes.** (Nova Scotian Inst., Trans. 10. pp. 49–66, 1898–1899.)—The results of a number of measurements of the conductivities of solutions of potassium sulphate and chloride and of mixtures of these salts are given; the calculated values for the mixtures agree with the experimental numbers for average concentrations not greater than 0·8 normal. Specific gravity and surface tension determinations of the solutions were also made. The results show that the specific gravity of a solution of the mixed salts having an average concentration of about 0·05 to 0·5 normal can be calculated by a formula given. The same holds for the surface tension, the concentration having the values 0·5 to 1·3. T. H. P.

989. *Superficial Tension in Organic Liquids.* **P. Dutoit** and **L. Friderich.** (Comptes Rendus, 130. pp. 327–330, Feb. 5, 1900.)—Investigation of values of the temperature coefficient of molecular superficial energy. This coefficient varies with the temperature in abnormal, but does not do so in normal liquids. For normal liquids this coefficient is not constant for all bodies, and varies within wider limits than have hitherto been observed. Ramsay and Shields' results are generally confirmed. A. D.

990. *Gravity Balance.* **R. Threlfall** and **J. A. Pollock.** (Roy. Soc., Phil. Trans. 193. pp. 215–258, 1899.)—Full description and discussion (*cf.* 1899, Abstract No. 1630). Quartz thread is found to be slightly viscous, about one-hundredth as much so as steel. Experiments on various forms of gravity balance. A. D.

991. *The Law of Partition of Kinetic Energy.* **Rayleigh** (Phil. Mag. 49. pp. 98–118, Jan., 1900) and **S. H. Burbury** (Phil. Mag. 49. pp. 226–228, Feb., 1900.)—Rayleigh takes for his starting-point Maxwell's paper of 1879 (Collected Scientific Papers, p. 713). To this Kelvin and others have made objections, Kelvin especially having framed a "decisive test case," which he holds to disprove Maxwell's law. Rayleigh considers this test case, and comes to the conclusion that it is not decisive, and is, in fact, covered by Maxwell's reasoning.

He then establishes *de novo* the admitted relation $dxdydudv = dx'dy'du'dv'$, or in generalised co-ordinates, $dp_1 \,.\,.\, dp_n dq_1 \,.\,.\, dq_n = dp'_1 \,.\,.\, dp'_n dq'_1 \,.\,.\, dq'_n$, when a system passes with conservation of energy from the state in which it is defined by $p\, q$, &c., to a state in which it is defined by $p'\, q'$, &c. We might say it passes from one state to the other *conservatis conservandis*, but in Rayleigh's view, following Maxwell, the energy E is the only *conservandum*. In the notation of this paper $fdxdydudv$ is the number of systems in the "phase" x, y, u, v. It is found that for a single variable the distribution is permanent when f is a function of E. A similar proposition is proved for two variables. The only assumption necessary, says the author, is Maxwell's assumption that all phases of equal energy lie on the same path, *i.e.*, that a system left to itself will sooner or later pass through every phase consistent with the conservation of energy. He does not say whether the same assumption is applicable to past time. The result is obtained, (33) p. 109, that for systems of any number of variables the distribution will be permanent if f is constant throughout the path. But E is constant also. Therefore f is a function of E.

This result being obtained, it is shown that if E can be reduced to a sum of squares—

$$E = q_1^2 + q_2^2 + \&c.$$

then—

$$\overline{q_1^2} = \overline{q_2^2} = \&c.$$

He maintains that the kinetic energy can always be reduced to a sum of squares. As to this, Kelvin had said the reduction to a sum of squares leaves the several parts of the whole with no correspondence to any defined or definable set of independent variables. This objection and also an objection made by Bryan are considered.

No express reference is made to any encounter or mutual action between the systems whereby any system may be made to change its path. He accepts the extreme consequence of his theory, if proved, namely, that the law of equal partition of kinetic energy must apply to all states of matter (see p. 115).

S. H. Burbury in referring to Rayleigh's article asks for a formal enunciation of the law, expressing what conditions are essential besides that of stationary motion. An example is given to show that stationary motion alone is not sufficient. Reference is then made to the kinetic theory of gases in which the law of equal partition of energy is indeed proved, but only, according to Boltzmann, on a certain hypothesis. And the question arises whether Boltzmann's hypothesis is true. In this writer's opinion Rayleigh's argument (p. 109 of the Phil. Mag., January, 1900) requires some assumption beyond Maxwell's assumption on which it is avowedly based. Also there may, he says, be other constants besides the energy which alone is used as constant by Rayleigh. Further, does not Rayleigh's method prove too much? If it holds, the consequence follows, according to this writer, that not merely the equal partition of energy, but the law of distribution of velocities, ϵ^{-hE}, must hold for all states of matter. S. H. B.

992. *Flux of Mechanical Energy*. **V. Volterra.** (N. Cimento, 10. pp. 337–359, 1899. Paper read before the Meeting of the Società Fisica Italiana, Sept. 21, 1899.)—The author refers to Poynting's law of the flow of energy in the electromagnetic field; also to the researches of Wien on the localisation and movement of energy. He supposes a system consisting in part of free

space and in part of space occupied by matter, in which the only forces acting are the Newtonian attractions, and the elastic forces, and he propounds the question whether it is possible to represent the flow of energy in all space on the assumption that no transformation into other forms of energy takes place. And this question is answered in the affirmative, namely, that it is possible so to represent it by means of quantities referring only to the point considered.

The energy of the Newtonian attractions due to a system of masses invariable in position can be put in the form $F^2/4\pi$ per unit of volume, where F is the force per unit of area. That is on the hypothesis on which the Newtonian system is based, namely, that of instantaneous action at a distance. If the masses at given positions, instead of being invariable, change with the time, as will be the case if the masses are in motion, a corresponding expression must hold for the variations of these masses. The author takes a new vector I denoting the time variation of F, and finds for the corresponding flux of energy the expression $-\frac{1}{4\pi}fI$, where f is the projection of F on the direction of I. He next considers the flux of kinetic energy and that of the elastic forces. The results obtained are as follows:—

The flow of mechanical energy at any point is the resultant of three vectors: (1) The vector I, denoting the rate of change of the Newtonian force multiplied by $U/4\pi$, U being the Newtonian potential; (2) The vector V, representing the velocity of motion of matter at the point considered, multiplied by $\rho\left(\frac{V^2}{2}-U\right)$, ρ being the density; (3) The product of V and the vector T, which represents the elastic tension.

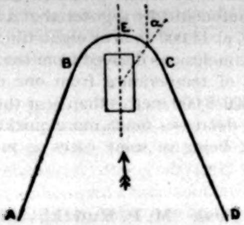
Finally he considers the motion of a spherical mass as equivalent to a magnetic element magnetised in direction of the motion. S. H. B.

993. *Range of Observable Phenomena.* **G. J. Stoney.** (Roy. Dublin Soc., Proc. 9. pp. 79–96, 1899.)—The author classifies the various measurable distances under four groups, as stellar distances, planetary intervals, laboratory measures, and molecular quantities respectively. Each of these stands to the next in the ratio of 10^{10} to 1. The uttermost region of the visible universe accessible to our telescopes is probably 10^{21} m. away. Light takes some 100,000 years to reach us from there, and, when the white spot flared up in the nebula of Andromeda some time ago, we were probably witnessing an occurrence which happened during the neolithic period. Light, by its wonderful speed, brings these enormous distances within our grasp. It also brings us into touch with extremely minute intervals by the smallness of its wave-lengths. The smallest distances with which we can even theoretically deal are larger than 10^{-13} m., and comprise the intervals concerned in events within atoms. A further subdivision is, to us, meaningless. The known universe, then, is comprised between the limits of ultra-stellar remoteness and infra-molecular proximity. Large as the range is, it might be infinitely larger in both directions. Mapped out as it is by the author, it resembles nothing so much as an absorption band in a spectrum, representing that portion of the material universe which happens to be accessible to human faculties. E. E. F.

994. *Resistance of Air to Projectiles.* **P. Vieille.** (Comptes Rendus, 130. pp. 285–288, Jan. 29, 1900.)—Experiments of Mach and Boys have shown that a

projectile moving in air causes an abrupt disturbance, which accompanies the projectile as a ripple A B C D.

The normal velocity of the parts A B and C D is equal to the velocity of sound, while that of E is equal to the velocity of the projectile. The author considers the motion of a projectile so large that the curve at E may be considered flat, and calculates the difference in pressure between the two sides of the ripple from the formula—



$$V = \sqrt{\frac{1\,P_0}{\rho_0\,2}\left(2\,m + (m+1)\,\frac{P_1 - P_0}{P_0}\right)}$$

Where V equals the velocity of the projectile, ρ_0 and P_0 are respectively the density and pressure of the air at rest, P is the pressure on the side of the ripple near the projectile, and *m* is presumably the ratio of the specific heats. The equation may be applied to the motion of the large *projectiles de rupture de la Marine*. Some results are given below :—

Speed of Cylindrical Projectile.	Observed Resistance in kgs. per sq. cm.	Theoretical Resistance.	Difference.
400 m.	1·25	1·58	0·33
600	3·26	3·78	0·52
800	6·23	6·85	0·62
1,000	10·15	10·81	0·66
1,200	15·01	15·64	0·63

Practice and theory agree so well up to 1,200 per second that it is interesting to calculate the resistances experienced and the temperatures attained by a body moving with high velocities as follows :—

Speed.	Resistance.	Temperature.
1,200 m.	15·64	680°
2,000	43·8	1,741
4,000	175·6	7,751
10,000	1,098	48,490

Without attaching absolute values to the numbers they give an idea of the way in which high temperatures may be attained by meteorites. A. G.

995. *Study of Upper Atmosphere with Kites and Balloons.* **L. Teisserenc de Bort.** (Soc. Franc. Phys., Séances, 3. pp. 126–135, 1899.)—This method of meteorological inquiry has been previously noticed in Abstracts Nos. 1642 and 1843 (1899). The present article contains a review of previous work, but new interest attaches to the statement that in September, 1899, observations were made at an altitude of 4,300 metres, the highest hitherto attained by any form

of kite. Considerable success has been attained in improvements permitting the ascent of small balloons during violent gales, even when wind had a velocity of 14 metres per second. These captive balloons have attained much greater altitudes than the kites, but of course difficulty was encountered on account of heating action of sun. By working at night by moonlight over 120 balloons have been launched, by means of which the curves of temperature and pressure have been automatically registered at a height of 13,000 metres on twenty-four occasions, at 14,000 metres eight times, and at 15,000 metres three times. The chief conclusions derived from the discussion of the results are: (1) The differences of temperature from one day to another may be greater at altitudes of 7,000–8,000 metres than near the surface of the ground; (2) That the temperature decreases much more quickly in the neighbourhood of regions of depression, being in some cases as much as 0·90° C. for 100 metres. C. P. B.

996. *Elastic Waves in Stone.* **M. P. Rudzki.** (Acad. Sci. Cracovie, Bull. 40. pp. 373–384, 1899.)—In an earlier paper the author has shown that pressure or stratification (or both causes together) produces such a condition in stone that it cannot on a large scale be considered isotropic. The present paper is mathematical, and an endeavour is made to obtain an idea of the form of the wave surfaces in granite when subjected to pressure. There are not sufficient experimental data to work out the subject fully, and so arbitrary values are given to certain constants. The author concludes that there are no grounds for assuming that torsional and dilatational waves are separated in such stones as granite, gneiss, &c. A. G.

997. *Dynamical Criticism of the Nebular Hypothesis.* **F. R. Moulton.** (Astrophys. Journ. 11. pp. 103–130, March, 1900.)—In this article the author discusses at some length the bearing of modern dynamical treatment on the various problems involved in the nebular theory of cosmic evolution enunciated by Laplace. The various criticisms put forward may be grouped into three categories: (1) Comparisons of observed phenomena with those which result from the expressed or implied conditions stated by the hypothesis; (2) Discussions of the question whether the supposed initial condition could have developed into the existing system; (3) Comparisons of these properties of the initial system with the one now existing, which are invariable under all changes resulting from the action of internal forces.

Under the first section of the discussion it is pointed out that the fact that the planes of the planetary orbits presenting considerable variations among themselves, and also that four satellites revolve in planes making practically right angles with the average plane of revolution of the system, are in direct contradiction with one of the chief deductions from the hypothesis. Other objections concerning observed phenomena are the unaccountable and suspiciously irregular distribution of the masses of the planets, and the unexplainable anomaly of the motion of the inner ring of Saturn.

The objections considered under the second category are that the lighter elements would have escaped from the mass; that matter would have been detached *continuously* instead of in rings at rare intervals; that if a ring were contracted into a planet except an infinitesimal remainder distributed along its path, the process of aggregation could not complete itself; that the gravitation in the masses occurring in the rare media would be so feeble that they would seldom come in contact, and that *Roche's limit* and a similar new criterion show that fluid masses of the density which must have formerly existed would be disintegrated by the disturbing action of the sun.

In the third section of the inquiry the question of conservation of moments of momentum is alone considered, but the results obtained are in such discordance with those required by the hypothesis as to indicate that the original nebulous mass, so far from being in any sense *homogeneous*, was *heterogeneous* to a degree hitherto considered improbable. Involved in the validity of the above statements is the question of the age of the earth, which has been calculated on the theory of the sun's contraction from a gaseous sphere arranged in concentric envelopes. C. P. B.

998. *Silicon in Stellar Spectra.* **J. Lunt.** (Roy. Soc., Proc. 66. pp. 44–50, March 8, 1900.)—Gill had called attention to three unknown lines in the spectrum of β Crucis (Roy. Soc., Proc. 65. p. 205), and McClean had also recorded them in his measures. Being engaged in obtaining a comparison spectrum of oxygen, the author used a tube containing CO_2 and excited it from a powerful 18-inch coil with four large jars and an air-gap in the secondary circuit. From this and an argon tube, spectra were obtained showing three lines which coincided with the three lines previously noted by Gill as unknown. Trying many different tubes it was found that with a discharge of low intensity the spectrum of the gas was obtained, while on passing a more intense discharge the gaseous spectrum disappeared, and was replaced by that of calcium and oxygen, together with the new lines. This pointed to the disintegration of the glass of the tube as the source, and trial of the spark between glass electrodes proved this to be correct. Finally a tube was made without capillary and filled with gaseous SiF_4, and this, showing the lines, proved conclusively that the three lines were due to silicon. Their wavelengths are λ4552·79, 4567·09, and 4574·68.

The paper closes with a discussion of the application of this spectrum of silicon as a criterion for the determination of relative stellar temperatures. C. P. B.

999. *Spectra of Polar Auroræ.* **Paulsen.** (Comptes Rendus, 130. pp. 655–656, March 5, 1900.)—Working in Iceland with two spectrographs, one with a quartz train, the author has obtained several photographs of the spectrum of the aurora borealis showing twenty-two lines, sixteen of which are new. Their positions are as follows :—

Strong lines : λλ337, 358, 391, 420.

Feeble lines : λλ353, 371, 376, 381, 393, 397, 402, 406, 412, 417, 422, 432, 436, 443, 449, 456, 463, 470.

Other lines have been traced between λ337 and λ250, but are too feeble for measurement. C. P. B.

REFERENCE.

1000. *Viscosity of Solutions.* **R. Hosking.** (Phil. Mag. 49. pp. 274–286, March, 1900.)—The work is experimental, and has for object the attainment of a knowledge of the data for some typical solutions up to at least the standard of accuracy reached by Thorpe and Rodger for the commoner liquids. The types chosen are solutions of sodium chloride of 1, 5, 10, and 20 per cent., representing electrolytes ; and solutions of cane sugar of 1, 5, 10, 20, and 40 per cent., representing non-electrolytes. Absolute values of the viscosity are given over a range of temperature from 0° to 90°. A. G.

LIGHT

1001. *Electromagnetic Theory of Light. I. Geometrical properties of the wave surface. II. Reflection and refraction at the boundary of crystals.* **A. McAulay.** (Phil. Mag. 49. pp. 228–242, Feb., 1900.)—The author begins by the statement that in a non-magnetic medium: (1) The electromagnetic displacement D is the exact mathematical equivalent of Fresnel's displacement. (2) The electromagnetic M.M.F., H, or the magnetic induction B, is the exact mathematical equivalent of McCullagh's displacement. (3) The electromagnetic E.M.F., E, is the exact mathematical equivalent of Kelvin's displacement.

In the second and third cases the mathematical equivalence extends, not only to the properties of plane waves within a medium, but also to the boundary conditions between two media. This is true in the first case also, in so far that the laws of reflexion and refraction at the boundary of isotropic transparent media, which result from the two theories, are the same. The four vectors, D, E, B, H, each divided by the square root of the energy per unit of volume, are denoted by δ, ϵ, β, γ. The ray velocity is ρ, the wave velocity is σ. Four geometrical propositions are proved in Part I. relating to these vectors. Proposition I. states that the loci of the extremities of these four vectors each drawn from a point O are ellipsoids with common centre O. He calls them the D-oid, E-oid, B-oid, and H-oid. Proposition II. states that the D-oid and E-oid are reciprocal polars, and the B-oid and D-oid are also reciprocal polars.

Proposition III. asserts that if the six vectors be arranged round a circle in the order δ, γ, ρ, ϵ, β, σ, each one is the vector product of its two next neighbours. Proposition IV. asserts that ϵ and γ are in direction conjugate to one another with regard to the E-oid and the H-oid. Similarly δ and β are conjugate to one another with regard to the D-oid and B-oid. The method employed in the proof of these propositions is that of quaternions.

Part II. treats of the reflexion and refraction at the surface of crystals, based on a theorem of W. Hamilton. There are generally at the surface five rays, viz., the incident ray, and two refracted and two reflected rays. The M.M.F.'s of these rays are denoted by H_1, H'_1, H'_2, H''_1, H''_2. The corresponding vectors of ray velocity are ρ, ρ'_1, ρ'_2, ρ''_1, ρ''_2. Hamilton's theorem is that if we suppose mechanical forces H, $-H'$, $-H'_2$, H''_1, H''_2, to act at the points whose vector co-ordinates are ρ, ρ'_1, ρ'_2, ρ''_1, ρ''_2, they will reduce to a couple whose plane is parallel to the face. The theorem holds only when both media are non-magnetic. S. H. B.

1002. *Optical Constants of Metals.* **J. Koenigsberger.** (Deutsch. Phys. Gesell., Verh. 1. 14. pp. 247–252, 1899.)—The author finds that the optical constants of metals (the refractive index and absorption) are independent of temperature. The metals used were: gold, silver, platinum, iron, nickel, and copper, in the forms of thin films deposited on glass. The range of temperature extended up to 360° C.

According to Maxwell's theory the index of absorption is equal to the product of the electric conductivity, the velocity of light, and the wave-length in the medium. The electric conductivity varies very greatly with the temperature, and therefore the index of absorption ought to vary accordingly. The author accounts for the disagreement by supposing that the electric conductivity as ordinarily measured is not the same as the conductivity for electric waves whose period is comparable with the wave-length of light. The conductivity according to this assumption may be divided into two parts, the one depending on the temperature satisfying slow electric oscillations, and the other independent of the temperature satisfying very rapid oscillations. The conductivity for Hertzian waves of about 4 metres wave-length has been found to be the same as for continuous currents. Rubens and Nichols have found, however, that the reflection and absorption of metals increases very greatly for long infra-red waves, the increase being partly dependent on the temperature.

The paper contains also a mathematical consideration of the subject.

J. B. H.

1003. *Metallic Reflection.* **E. Hagen** and **H. Rubens.** (Ann. d. Physik, 1. 2. pp. 352–375, Feb., 1900.)—The authors determined the reflective powers of various metals and of glass mirrors for the various rays of the visible spectrum by a photometric method. The substances were put into the shape of concave mirrors, and the real image of a strip of incandescent platinum was formed by reflection close to the object, and compared with the latter by a spectro-photometer. As a general rule, the reflective power of metals increases with the wave-length of the light. This is of course especially the case in gold and copper. Thus the reflective power of gold for rays of wave-length 700 is the same as that of silver. As regards speculum metals, those of Rossé, Brashear, and Schroeder, all have about the same reflective power, which is equal to that of nickel. Brandes and Schuenemann's nickel-iron alloy is not highly reflective, but exceedingly durable, and takes a fine polish. Some of Mach's aluminium-magnesium speculum metals have a very high reflective power, which approaches that of silver. (See also 1900, Abstract No. 463.)

E. E. F.

1004. *Refraction in Crystals.* **L. T. More.** (Phil. Mag. 49. pp. 262–274, March, 1900; read in part to the American Mathematical Society, August, 1899.)—In doubly refracting media light breaks up into two parts which follow different paths unless the light traverses a path coinciding with the optic axis of the crystal, or unless the path coincides with the major or minor axis of the elliptic section of the wave surface. That these are only two special cases of an infinite number in which the paths of the ordinary and extraordinary coincide was first shown by Brace.

The geometrical construction for obtaining the coincidence of the two rays follows at once from Huyghen's principle. Suppose O is the centre of the principal section of Fresnel's wave surface, and suppose any ray OEC cuts the circle in C and the ellipse in E. If we draw tangents at C and E these will meet in a point S. If now OS be taken as the surface of the crystal, any ray which is incident on it at such an angle as to make the ordinary ray pass along OC will have the ordinary and extraordinary rays coinciding in OCE.

In the present paper the author considers mathematically the locus of S, the intersection of the tangents. The equation is of the eighth degree, and represents a curve symmetrical about the axes. Diagrams in the paper show the form of the curves for the three principal sections of a biaxial crystal, and also for both a negative and positive uniaxial crystal. The mathematical results of the paper are applied to determine a section of Icelandspar and one of Aragonite which will give three pairs of coincident ordinary and extraordinary rays. In order to obtain these in practice it is necessary to immerse the crystal in a suitably refracting medium, as some of the coincident rays are beyond the critical position when the crystal is in air.

J. B. H.

1005. *Paris Exhibition Telescope.* **J. N. Lockyer.** (Nature, 61. pp. 178–181, 1899.)—Several articles have been written on this instrument, giving isolated details; the present one is more complete. It is hoped that the magnifying power employed under good observing conditions will show the moon's surface as if it were only 67 kilometres distant, so that any feature more than 1 metre square may be detected. The focal length is 100 metres (328 feet) or about 4½ times that of the Yerkes telescope. The glass mirror, 2m. diam., was cast at the Jeumont glass works under the direction of Despret, and has a thickness of 30 cm., weight 3,600 kilos. The advantage of reflecting the light from a celestial object from the mirror of a siderostat driven by clockwork into the fixed telescope is manifest in an instrument of this size, as a dome 340 feet in diameter would have been necessary, the mechanical difficulties in constructing and moving which would have been enormous. Besides this, the use of the siderostat ensures greater stability, and saves the observing astronomer much unnecessary fatigue and loss of time in that he has never to change his position of observation.

The pedestal for the siderostat is 8 metres high and 8 metres long, resting by six screws on a stone slab 1·70 metres high. The north part of pedestal supports the polar axis with driving and position circles, and also the sliding pivot for the declination circle. The mirror and cell together weigh 6,700 kilos. The cell of mirror is lined with felt and the weight of the mirror is distributed by a carefully adjusted system of levers and counterpoises, and in addition, at the base, the whole framework rests in a basin of mercury, the quantity of which is adjusted so as to float about nine-tenths of the whole movable weight. The total weight of the siderostat is 45,000 kilos.

The telescope proper is provided with two object glasses, one for visual work, the second for photography. Each is 1·25 metres in aperture. The glass for these was made by Mantois, and the final optical grinding and finishing is by Gautier. The flint lens weighs 360 kilos, the crown 220 kilos. The telescope tube is of sheet steel, 2 mm. thick, 1·50 metres in diameter, and weighs 21,000 kilos. It is supported horizontally on eight cast-iron brackets resting on stone pillars. Both objectives are mounted on the same carriage, by which either can at once be placed in line with the tube. The eyepiece tube is double, the interior part being rotated by clockwork, so that the movement of the stars is neutralised. Illustrations are given showing the various parts to scale.

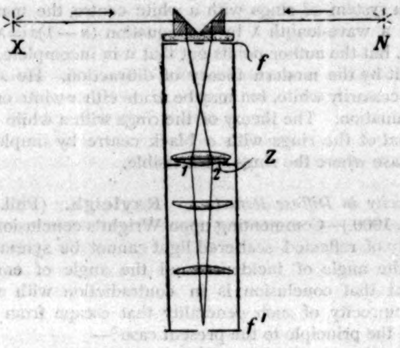
C. P. B.

1006. *Adjusting Photographic Telescopes.* **G. Meslin.** (Comptes Rendus, 130. pp. 495–496, Feb. 19, 1900.)—Lippmann has described a convenient method of focussing a collinator by interposing a pair of glass plates in the path of the transmitted beam (Journal de Physique, p. 594, 1899), and the present paper is an extension of the idea for adjusting the photographic plate at the focus of a telescope.

The advantage is that the adjustment is recognised by the disappearance of a duplicated image instead of the more or less sharp appearance of the single image as usually examined. The procedure is to hold an opaque screen in the path of the light from the objective, then while the ground glass is exactly at the correct focus, a single image will be seen, but if it is away from the conjugate focus, there will be a duplication of the image, caused by the light from the two parts of the objective not masked by the interposed opaque screen. C. P. B.

1007. *König Spectro-photometer.* **F. F. Martens.** (Deutsch. Phys. Gesell., Verh. 1. 15. pp. 280–284, 1899.)—The author describes certain improvements made in König's spectro-photometer of 1885. The telescope is movable about a horizontal instead of a vertical axis, and certain disturbing reflections are avoided. E. E. F.

1008. *Prism Photometer.* **F. F. Martens.** (Deutsch. Phys. Gesell., Verh. 1. 15. pp. 278–279, 1899.)—The two beams of light to be compared enter by the two apertures in the diaphragm *f* (see diagram). Between *f* and a second opaque diaphragm *f*′ a twin prism Z with some lenses is so arranged that the two diaphragms *f* and *f*′ are projected upon each other, and that the edge of the twin prism is seen sharp from *f*′. The observer thus sees the two halves of the prism each through a different aperture of the diaphragm *f*. This comparison apparatus can be used in connection with various measuring apparatus. It may be mounted on an optical bench. It fulfils all the conditions laid down by Weber and by Lummer and Brodhun for instruments of photometric comparison. For each field only receives light from one of the sources, the two fields are separated by a perfectly sharp line, and that line disappears entirely at equal luminosity. E. E. F.



1009. *Diffraction in Optical Instruments.* **K. Strehl.** (Zeitschr. Instrumentenk. 19. pp. 364–371, Dec., 1899.)—The author points out the various fallacies occasioned in the construction and use of optical instruments by the neglect of certain principles of diffraction. Geometrical and physical optics look upon light from two diametrically opposite points of view. Geometrical optics deal with the "ray," and consider it as being propagated in a straight line. In reality, the greater the efforts that are made for isolating a ray, the more does it tend to disappear. The diffraction theory starts from the wave surface, and assumes that light is propagated primarily in spherical wave surfaces. Its smallest element is a portion of luminous energy evenly distributed over a very small surface. The "cone of rays" is a fiction of geometrical optics, which leads to such fallacies as that the apparent brightness of fixed stars increases with the square of the aperture, and is independent of the magnification. In the construction of achromatic objectives, the concentration of the light of two different wave-lengths is erroneously considered to be of paramount importance. The author shows that the so-called apochromatic lenses are nothing but objectives with a strongly diminished secondary spectrum. It is only when extremely great focal lengths or small apertures are used that we have truly apochromatic lenses.

E. E. F.

1010. *Fringes of Mixed Plates.* **C. Fabry.** (Journ. de Physique, 8. pp. 595–599, 1899.)—Fringes of mixed plates are observed in a transmission apparatus for Newton's rings, in which the thin layer, instead of being a layer of air, consists of two different media, such as a layer of air interrupted by numerous drops of water. There is interference between the light which has traversed the air and that which has traversed the water. If there is normal incidence, and n is the refractive index of the water, and e the thickness of the layer, the difference of path between the two rays is $(n-1)e$. We shall therefore have a system of rings with a white centre, the maxima of which are defined for a wave-length λ by the equation $(n-1)e=\lambda$. This is the classical theory, but the author points out that it is incomplete, and proceeds to supplement it by the modern theory of diffraction. He shows that the centre is not necessarily white, but may be made either white or black according to the illumination. The theory of the rings with a white centre may be derived from that of the rings with a black centre by simple reversal, and the aid of the case where the rings are invisible. E. E. F.

1011. *Reciprocity in Diffuse Reflection.* **Rayleigh.** (Phil. Mag. 49. pp. 324–325, March, 1900.)—Commenting upon Wright's conclusion that "a law for the intensity of reflected scattered light cannot be symmetric in reference both to the angle of incidence and the angle of emergence," the author says that that conclusion is in contradiction with a fundamental principle of reciprocity of such generality that escape from it is difficult. He thus applies the principle to the present case:—

"Suppose that in any direction (i) and at any distance r from a small surface (S) reflecting in *any manner* there be situated a radiant point (A) of given intensity, and consider the intensity of the reflected vibrations at any point B situated in direction ϵ and at distance r' from S. The theorem is to the effect that the intensity is the same as it would be at A if the radiant point were transferred to B. The conclusion follows that whatever may be its character in other respects, the function of i and ϵ which represents the intensity of the reflected scattered light *must* be symmetrical with respect to these quantities.

"The actual departures from the reciprocal relation found by Dr. Wright were not very large, and they may possibly be of the nature of experimental errors. In any case it seems desirable that the theoretical difficulty in accepting Dr. Wright's conclusion should be pointed out." E. E. F.

1012. *Kirchhoff's Law and Electrically Glowing Gases.* **M. Cantor.** (Ann. d. Physik, 1. 3. pp. 462–465, March, 1900.)—The light from an arc lamp falls upon two mirrors placed vertically one below the other, and having their planes vertical and normal to each other. The lower mirror reflects the beam into a vacuum tube and out at the other end, where it is received on another mirror, and reflected back again through the tube, finally entering a spectroscope provided with a Vierordt double slit. The upper mirror reflects the beam direct into the spectroscope. Of the two beams thus compared, one traverses the glowing gas in the vacuum tube twice, while the other does not. The observer is, therefore, able to determine whether the first beam is perceptibly absorbed by the glowing gas. Allowance must be made for illumination by the glowing gas itself. The author finds that there is no perceptible absorption. As by Kirchhoff's law the ratio of the emission to the absorption equals the emission of a black body at the same temperature, the glowing gases should have an extremely high temperature. But since they have not, Kirchhoff's law does not hold for electrically glowing gases.

E. E. F.

1013. *Spectrograph.* **J. Hartmann.** (Zeitschr. Instrumentenk. 20. pp. 17–27, Jan., and pp. 47–58, Feb., 1900.)—This paper deals with investigations which have been conducted during the last two years at Potsdam preparatory to building two spectrographs to be used in conjunction with the large refracting telescope in the observatory at Potsdam for the photography of stellar spectra.

The points dealt with are: (1) Choice of objectives for collimator and camera; (2) Relative light intensity from simple and compound prisms; (3) Requisite size of prisms; (4) Testing and adjusting the apparatus; (5) Sliding diaphragms for the slit for stellar spectrography.

The conditions to be satisfied by the collimator objective are just those which an astronomical objective fulfils, namely, absence of spherical aberration and good achromatism for rays from a point on or near the axis. For the camera objective the conditions are different. The lens must be a very wide angle lens and must have no spherical aberration. The achromatism, on the other hand, is of secondary importance, as the photographic plate may be set at an angle. If the lens is made of two glasses achromatised for two wave-lengths, then the focal length is a minimum for the wave-length midway between these two in the spectrum. The photographic plate may therefore be set up perpendicular to this ray, and the lenses may be so chosen that when this ray is in focus all the rest of the spectrum is practically in focus.

With compound prisms it is generally assumed that greater dispersion can be obtained than with simple prisms with the same loss of light, owing to the diminished number of surfaces between glass and air through which the light has to pass. The author here shows, however, that this increase of light is lost in the increase of thickness of the glass and in the less favourable angle of incidence which it is necessary to adopt with the compound prism.

With regard to the size of the prisms, the author finds that besides the saving in weight and cost when the prism is made smaller so as not to catch the whole of the parallel circular beam from the collimator, there is also a gain in brightness of the spectrum, due to the diminished absorption in glass. The reduction must not be carried too far, however. The best conditions are obtained when a segment of the circular beam subtending at the centre an angle of 80° passes the edge of the prisms. No light, however, must pass the base edge.

For an account of the methods of testing the lenses and prisms and the methods of adjustment reference must be made to the paper. J. B. H.

1014. *Rotatory Power of Active Valeric Acid.* **P. A. Guye and E. Aston.** (Comptes Rendus, 130. pp. 585–588, Feb. 26, 1900.)—The anomalous change in specific rotatory power exhibited by amyl alcohol (see 1898, Abstract No. 867) in its passage from the liquid to the vaporous state, is not shown by all active substances which, like amyl alcohol, are polymerised when in the liquid state. Thus, the authors find that the rotatory power of valeric acid decreases continuously as the liquid is heated and finally vaporised. Further, in aqueous solution, the specific rotation of valeric acid does not change with the concentration, and is, besides, considerably greater than the value in ethylene bromide, the rotatory power in the latter case varying greatly with the concentration of the solution; hence it follows that valeric acid, like amyl alcohol, is composed of a mixture of simple molecules ($C_5H_{10}O_2$) and of molecular complexes $(C_5H_{10}O_2)_n$, the former having a higher optical activity than the latter. The fact that the specific rotation of amyl alcohol shows diminution when the liquid is vaporised, whilst that of valeric acid exhibits no such behaviour is due to two causes: (1) As shown by Ramsay and Shields, in the case of the primary alcohols of the fatty series, the action of heat in resolving the complex molecules is very marked, whilst with the fatty acids such action is scarcely appreciable. (2) The vapour density of amyl alcohol is about normal, while that of valeric acid indicates the presence of a large proportion of complex molecules; in the latter case, then, the specific rotation of the simple molecules is masked by that of the more numerous molecular complexes. T. H. P.

1015. *Kerr Effect.* **F. J. Micheli.** (Ann. d. Physik, 1. 3. pp. 542–565, March, 1900.)—The Kerr phenomenon in cobalt and nickel is disturbed by the presence of surface contaminations even in very minute quantities. In these metals, and also in steel, the critical angle of incidence is lowered by impurities. Even in the case of the cleanest mirrors, the magneto-optic phenomena in nickel and cobalt cannot be represented by one constant only. The introduction of a second magneto-optic constant still leaves distinct differences between theory and observation. These differences are partly explained, and can to a certain extent be calculated, by assuming that the mirror is not magnetised in a perfectly homogeneous manner. When that is done, it is found that the "equatorial" magnetisation produced by a field parallel to the mirror and to the plane of incidence is in the case of nickel and cobalt somewhat less on the surface than in the interior, even when the thickness of the surface layer does not exceed $\frac{1}{15}$ of the wave-length of light, or $\frac{1}{50}$ in the case of cobalt. E. E. F.

1016. *Absorption of Light in a Magnetic Field.* **A. Righi.** (Journ. de Physique, 8. pp. 608–610, 1899. From Bologna, Accad. Scienze, May 28, 1899.)—The acquisition of a large Rowland grating has enabled the author to proceed further in the study of the properties of the hyponitrite of sodium and of sodium vapour, traversed by a beam parallel to the magnetic lines of force. The absorption lines of hyponitrous acid which undergo a sensible change owing to the action of the field are distributed in two groups, one of them situated between the components of the D line, and the other between 5920 and 5924. When the field is made, these lines become blurred and get mixed up together in a single band. E. E. F.

1017. *Reciprocity in Magneto-optic Phenomena.* **O. M. Corbino.** (N. Cimento, 10. pp. 408–419, 1899.)—In the Amer. Journ. Sci. 90. p. 196, 1899,

Sheldon finds a magnetic field created by a bundle of light rays whose plane of polarisation is undergoing rapid rotation; but the author, by several methods which ought to show a much greater effect, entirely fails to confirm this result and explains Sheldon's experiments by various disturbing causes.
A. D.

1018. *Zeeman Normal Triplet.* **W. Voigt.** (Ann. d. Physik, 1. 2. pp. 376–388, Feb., 1900.)—The formulæ obtained by the author for the normal Zeeman triplets are very complicated, and he has hitherto confined himself to a first approximation. The agreement between the theoretical results so obtained and the observations made by Zeeman have encouraged him to pursue the matter to a further approximation, and he thus obtains a theoretical value of the dissymmetry observed in the normal triplet, and quite lately also in the quadruplet. The observed dissymmetry is very slight even in the most favourable case.
E. E. F.

1019. *Experimental Work with the Echelon Spectroscope.* **Blythswood** and **E. W. Marchant.** (Phil. Mag. 49. pp. 384–403, April, 1900.)—The first *echelon* grating made in this country, by Hilger, is in the possession of Lord Blythswood, who has been using it at his laboratory at Renfrew, N.B. The present article gives details of the method of mounting, plan of work, and determination of fundamental constants of the instrument. The echelon itself consists of fifteen plane parallel plates of light flint glass, each about 7·5 mm. thick, the consecutive steps being originally set at 1 mm. intervals, but this has now been reduced to 0·5 mm. The whole is mounted on the table of a large goniometer, the telescopes of which have object glasses of 2 inches aperture and 28 inches focus. As approximately monochromatic light must be used the light from the source was first passed through a subsidiary prismatic train, the spectrum given by which was focussed on the slit of the echelons pectroscope, and then, by turning the prisms, light of any desired wave-length could be made to pass into the echelon.

From statements of refractive indices for five wave-lengths given by the glass-makers, the constants in Cauchy's dispersion formula were determined, so that the equation became—

$$u_\lambda = 1{\cdot}5958 + \frac{8{\cdot}03 \times 10^5}{\lambda^2} + \frac{1{\cdot}53 \times 10^{12}}{\lambda^4}$$

The authors then give the theory of the instrument as stated by Michelson (see 1898, Abstract No. 1118), with its application to the present specimen.

They then describe the peculiarities incident to the use of the echelon, and the appearance of the spectra given by it are so unusual as to need some little preliminary study. In general several orders of spectra are visible in the field of view simultaneously, but the spectrum constituting any one order may also be presented under a number of different aspects. There may be a single line, or two lines of equal intensity, or an infinite number of combinations of two lines of varying intensity. These changes are brought about by slight rotation of the echelon, and the most advantageous position is when the plates are *normal* to the incident light.

An illustration is given of the electromagnet used for producing the Zeeman effect it was proposed to study. The pole-pieces are 5 inches square, and the winding such that with a current of 20 amperes, a field of 24,000 c.g.s. units can be maintained across an 8 mm. air-gap, and 40,000 across a 1 mm. gap.

The Zeeman effect considered was that of mercury vapour, and photographs of the behaviour of the lines λ4358 (blue) and λ5460 (green) were obtained, the exposure varying from ten to twenty minutes with the former, to quite two hours for the latter. Reproductions of these photographs are given in the paper, and show very clearly the multiple groupings with varying fields. With a field of 23,800 the line λ4358 becomes a sextet; the green line, λ5460, becomes a septet with a field of 23,400. Measurements are given for other lines also, λ5768 and λ5790. As the two yellow lines of mercury are produced by relatively simple ionic movements, the value of *e*/*m* has been calculated for them from Larmor's equation (1). These values are :—

$$\lambda 5790,\ e/m = 17{\cdot}2 \times 10^6$$
$$\lambda 5758,\ e/m = 18{\cdot}9 \times 10^6.$$

The paper concludes with several suggestions as to advisable modifications in future instruments. The interference of the several orders visible concurrently may be partly remedied by increasing the constant of the echelon, without, however, equally reducing the resolving power. As Michelson suggested, the constant may be reduced by immersion in water, but this would reduce the resolving power to at least one-third of its original value, and therefore is inadvisable. A better proposal is to construct the echelon from *thinner* plates, and using more of them. A useful instrument might be made, say, of thirty plates, 4 mm. thick, set at 0·5 mm. or even 0·25 mm. steps.
C. P. B.

1020. *New Source of Light for Spectrometer.* **C. Fabry** and **A. Pérot.** (Comptes Rendus, 130. pp. 406–409, Feb. 12, 1900.)—After describing and criticising the various methods used for obtaining a suitable source of illumination in work with the spectrometer, the authors give a description of an apparatus in which two pieces of the metal to be investigated are connected to the poles of a battery of secondary cells (60 volts); one of them is made to oscillate and come into contact with the other, and then is immediately withdrawn. At each separation an arc is formed which is quenched and then at once remade at the next contact; as the action is rapid the light appears continuous. In the circuit is inserted a rheostat and a self-induction (primary of a Ruhmkorff coil) to increase the spark at break. The alternating movement is produced by the attraction of an electromagnet on an iron armature. The whole apparatus is enclosed in a vacuum. The spectra thus obtained are almost identical with those from the electric arc; they are much less complex than those produced with the induction discharge with capacity.

It is found that in the case of the green ray of mercury the wave-length of radiation emitted by the spark trembler described is exactly the same as when it is produced by a Michelson's tube or by the mercury arc *in vacuo*. J. J. S.

1021. *Constitution of Yellow Lines of Sodium.* **C. Fabry** and **A. Pérot.** (Comptes Rendus, 130. pp. 653–655, March 5, 1900.)—Michelson has stated that each of the yellow sodium lines is itself made up of two components. The authors, however, noticed in their experiments that although the lines were seen double, the distance between the components continually varied as the intensity of the source of light was altered. This, of course, was in opposition to the idea of their being true multiple lines, and the authors state their reasons for supposing the doubling to be due to ordinary reversal. It is well known that these two sodium lines are very easily reversed, and the unsteadiness always noticed in interference work when these radiations are employed may be really attributed to this phenomenon. C. P. B.

1022. *Spectrum of Silicon.* **J. N. Lockyer.** (Roy. Soc., Proc. 65. pp. 449–452, Jan., 1900.)—In 1895 a strange double line was found in the spectrum o the gas distilled from the mineral eliasite. Some time later the same lines appeared in the spectrum of a vacuum tube of hydrogen when worked with a high tension coil with condenser in secondary circuit. This led to the glass itself being regarded as the source of the line, and direct examination of the spark from powdered silica showed the lines plainly. The wave-lengths of these lines are λλ4128·3 and 4131·4, and both are prominent in the spectrum of α Cygni.

In the later experiments a second much wider double was also noticed, having the positions λλ3856·1 and 3862·7, and these also are present in α Cygni.

Still more recent photographs of the spectrum of silicon obtained with the greater tension produced by the Spottiswoode coil, have shown other silicon lines which have also been identified in the spectrum of α Cygni. The more important of these two groups, (*b*) 4089·1 and 4116·4 ; (*c*) 4552·8, 4568·0, 4575·3. Calling the first four lines mentioned group (*a*), it is found that the group (*b*) is characteristic to the conditions of highest temperature, and a diagram is given showing that the three groups persist differently in stars of varying temperatures. Thus the group (*a*) predominates in stars of the type of β Orionis (Rigel), the group (*b*) in stars of the type of ζ Orionis, and the group (*c*) in stars of the type γ Orionis (Bellatrix). C. P. B.

1023. *Reference Points in Spectra.* **M. Hamy.** (Comptes Rendus, 130. pp. 489–492, Feb. 19, 1900.)—The author discusses the advisability of avoiding the use of spectrum lines which have been found to be multiple for standard determinations of wave-length. He suggests as preliminary standards the lines of cadmium at wave-lengths 6438·472, 5150, and 4660, which are, as far as at present known, produced by simple radiations. Experiments are in progress to determine others for intermediate positions. C. P. B.

1024. *Discharge by Röntgen Rays.* **S. Guggenheimer.** (Deutsch. Phys. Gesell., Verh. 1. 15. pp. 272–274, 1899.)—When the air between the two plates of a condenser is ionised by Röntgen rays and a current passes between the plates in consequence, the current increases with every increase of the difference of potential until a certain limiting value is reached, beyond which the current does not increase, whatever be the value of the potential difference. At this point, according to J. J. Thomson, the current strength is proportional to the difference of the squares of the electric force at two points. The author has made some measurements to examine this relationship. The electric force was determined by means of Kelvin's water-jet arrangement. The relation in question was verified in three different series of measurements within about 5 per cent. E. E. F.

1025. *Condensation Nuclei.* **C. T. R. Wilson.** (Roy. Soc., Proc. 65. pp. 289–290. Roy. Soc., Phil. Trans. 192. pp. 403–453, and 193. pp. 289–308, 1899.)—When final volume under adiabatic expansion is less than 1·25 times the initial volume in dust-free air saturated with moisture, no precipitation takes place ; when it is more there is some precipitation, with comparatively few drops ; beyond 1·38 times the precipitation is abundant. Apparently between 1·25 and 1·38 the precipitation is on nuclei other than the molecules of gas or vapour ; beyond that it is upon these molecules. Under Röntgen rays anything beyond 1·25 is equivalent to ordinary air at beyond 1·38, so that nuclei are formed under the influence of these rays; below 1·25, no precipitation. Water condenses much more rapidly on negative than on positive ions. To cause water to condense on positive ions the ratio must be 1·25 (= fourfold saturation); for negative ions it must be 1·31 (= nearly sixfold saturation). Negative ions must therefore preponderate as condensation nuclei, and if they act as such in the atmosphere a preponderance of negative electricity will be carried down by precipitation to the earth's surface. There is some evidence that such ions are likely to be present under normal conditions in the atmosphere. The limit of expansion at which condensation takes place in "dust-free" air, initially saturated, is identical with that required to make water condense on ions. The number of nuclei is so small as not to be inconsistent with the absence of sensible electrical conductivity in air. But the nuclei do not appear to be ordinary free ions, in respect that an electrical field does not remove them. Possibly the ionisation is developed by the process of producing the supersaturation. [See also Abstracts Nos. 1033 (1898) and 662 (1899).] A. D.

1026. *Röntgen-Ray Photometry.* **H. Boas.** (Deutsch. Phys. Gesell., Verh. 1. 13. pp. 242–244, 1899.)—The intensity and quality of a beam of Röntgen rays is defined by its absolute luminous effect as measured with a fluorescent screen of definite quality at a certain distance from the tube, and by the ratio of the penetrating rays to the absorbed rays. If there is a proportionality between the rate of discharge of an electrified body and the fluorescence, the ionising properties of the rays may be used for determining their intensity. The second or "contrast effect" may be measured by means of a half-shadow polariscope, through which two parts of the screen are viewed, one of them illuminated by the rays direct, and the other by rays which have traversed a platinum plate of definite thickness. E. E. F.

1027. *Absorption of Röntgen Rays.* **E. A. W. Henley.** (Roy. Dublin Soc., Proc. 9. pp. 31–32, 1899.)—Pieces of the substances under investigation were cut in the form of right-angled triangular prisms, which were laid with their bases over a photographic plate. They yielded radiographs of intensity varying according to the thickness, and comparisons with standard prisms could thus be easily made. The organic substances studied were frozen in order to yield hard geometrical figures.

The first comparison was made between muscle and fat of a sheep. As the result of seventeen measurements made on different prints from various negatives, the ratio of the opacities of muscle and fat was found to be 2·5 : 1. The next comparison was made between bone and muscle. In the case of bone, variations occurred according as the specimen contained different proportions of cancellous tissue and of compact tissue. The results given are the mean of all the measurements. The ratio of the opacity of bone to that of muscle was found to be 1·6 : 1, as obtained from eleven measurements. This result, when combined with the previous one, gives the ratio of the opacity of bone to fat as 4 : 1. Hence, the numbers obtained, as representing the relative opacities of bone, muscle, and fat, are 4, 2·5, and 1. E. E. F.

1028. *Radio-activity of Ultra-violet Light.* **P. Lenard.** (Ann. d. Physik, 1. 3. pp. 486–507, March, 1900.)—Kathode rays and other kinds of radiation have the power of imparting electric conductivity to gases, producing nuclei of condensation in them and converting oxygen into ozone. The author points out that similar properties are possessed by ultra-violet light. As regards the formation of nuclei, the author has found, since his first experiments in 1889, that the formation of condensation nuclei in steam is not due to ordinary ultra-violet rays, but to rays which are completely absorbed by a layer of air 2 cm. thick. Spectroscopic observations showed the wave-length of these rays to be shorter than those hitherto mapped, ranging as they do from 160 to 190 $\mu\mu$. The source of radiation employed was an induction coil provided with zinc or other terminals. Oxygen, air, and carbonic acid were equally affected, but coal-gas only slightly so, and hydrogen not at all. This is consistent with the fact that hydrogen does not absorb rays filtered through 1 cm. of air.

Electric discharge effects are also produced by these extreme ultra-violet rays. This was proved most strikingly by conveying the gases which had been exposed to the radiation through the space between two concentric brass tubes forming a condenser, and noting their discharging effect. The effect is least in the case of hydrogen, and greatest in the case of carbonic acid. The gas loses its discharging power very shortly after the impact of the radiation. The formation of ozone by these rays is very prompt and easily proved. It is at once evident from the strong smell of ozone in the neighbourhood of the quartz window. All these effects are intercepted by a plate of mica, which does not allow rays of these very short lengths to pass.

The ordinary sources of light do not contain rays of this description, but the electric arc does. The author is strongly of opinion that sunlight contains such rays. They are absorbed in the higher regions of the air, and there they produce the electric conductivity noticed by Elster and Geitel at high elevations. E. E. F.

REFERENCES.

1029. *Refraction through a Prism.* **A. de Gramont.** (Comptes Rendus, 130. pp. 403–406, Feb. 12, 1900.)—A note accompanied by a graphical representation of some of the consequences deduced from the formulæ for refraction through a prism. (See 1899, Abstract No. 1677.) J. J. S.

1030. *Optical Constants of Telescopes.* **H. Kellner.** (Zeitschr. Instrumentenk. 20. pp. 1–17, Jan., and pp. 33–46, Feb., 1900.)—These two papers deal with the different methods used for determining the magnification and the width of field, both real and apparent, in telescopes. Besides describing the methods, their probable errors are also discussed. J. B. H.

1031. *Intensity of Telescopic Vision.* **A. Gleichen.** (Zeitschr. Instrumentenk., Beib. 1. pp. 1–4, Jan. 1, 1900.)—This paper contains a new proof of the fact that the apparent brightness of any surface viewed through a telescope can, under the most favourable conditions, only be equal to the brightness when viewed with the naked eye, and can never exceed it. J. B. H.

1032. *Siderostat and Heliostat.* **M. A. Cornu.** (Astrophys. Journ. 11. pp. 148–162, March, 1900.)—This paper contains a mathematical study of the law of diurnal rotation of the optical field of the siderostat and heliostat. The direction and period of rotation and the angular velocity of rotation at any time are given, and also the conditions for a fixed optical field. The relative advantages of the siderostat and heliostat for different astrophysical purposes are also considered. J. B. H.

1033. *Do Röntgen Rays Promote Cooling?* **A. Amerio.** (N. Cimento, 10. pp. 366–372, 1899).—Mathemactial discussion and experimental enquiry; results negative. A. D.

HEAT.

1034. *Specific Heat of Metals, Alloys, and Graphite.* **U. Behn.** (Ann. d. Physik, 1. 2. pp. 257–269, Feb., 1900.)—The specific heats measured were those of antimony, tin, cadmium, silver, zinc, magnesium, graphite, brass, and three tin-lead alloys. The theoretical conclusions arrived at by Richarz are in the main confirmed. Those metals which do not obey the law of Dulong and Petit show a great variation of the specific heat with the temperature, and the cause of both phenomena must be sought in the fact that in them the displacements of the atoms no longer vanish in comparison with the distances between them. This occurs when the atomic intervals are small, and also when the displacements are large. The latter case will occur where the atomic weight is small, since atoms of small weight must attain greater velocities, and hence also greater elongations. In the diagram of atomic volumes in terms of atomic weights, the elements Li, K, Rb, and Cs, occupy a special position on that account. E. E. F.

1035. *Thermal Data for Benzene.* **K. Tsuruta.** (Phys. Rev. 10. pp. 116–122, Feb., 1900.)—From the curve best representing Young's calculated and Griffiths and Marshall's measured values of the latent heat of vaporisation the specific volumes of the saturated vapour are deduced, those of the saturated liquid experimentally found by Young being assumed as correct. The "law of straight diameter" is found to hold satisfactorily, not only from 80° C. to the critical temperature as remarked by Young, but also from 80° C. down to the triple point 5·3° C., though close examination of the results shows this law to be a first approximation only.

The curves for the steam and hoar-frost lines between —1° C. and the triple point judged by the author to best represent the whole of the experimental measurements hitherto published for benzene are then given, and are satisfactorily compared with the approximate theoretically deduced formula—

$$R \log (p_s/p_l) = (F_o/T_o) \log (T/T_o) - \tfrac{1}{2}(c_s - c_l) \log^2 (T/T_o),$$

where p_s and p_l, c_s and c_l are respectively the saturation pressures and specific heats of the solid and liquid phases in contact with the vapour phase at T, and F_o is the latent heat of liquefaction at the triple point T_o; the values taken for the constants being—

$$R = 1{\cdot}971/78,\ F_o = 30,\ T_o = 278{\cdot}3,\ c_s = 0{\cdot}2032,\ c_l = 0{\cdot}3350.$$

R. E. B.

1036. *Specific Heats of some Organic Materials.* **G. Fleury.** (Comptes Rendus, 130. p. 437, Feb. 12, 1900.)—Dry cellulose has the specific heat 0·366; cellulose containing 7 per cent. of water, 0·41; dry wool, 0·393; undried wool, with 11 per cent. of water, 0·459; dry leather, 0·357; leather containing 16 per cent. of water, 0·45. The cellulose used was obtained from Berzelius paper and left no appreciable ash. The wool was woven and was washed with ether. The leather consisted of chips of thick ox-hide, ready tanned, as used for saddles; it was not ash-free. T. H. P.

1037. *Determination of Melting-Points.* **M. Kuhara** and **M. Chikashigé.** (Chem. News, 80. pp. 270–271, 1899.)—The finely divided substance is placed between the two halves of a microscope cover-slip, and is then arranged in a small holder of platinum-foil and hung, together with a thermometer, in a wide test-tube. The test-tube is immersed nearly to its mouth in a sulphuric acid bath, which is heated in the ordinary way. Before melting occurs, the cover-glass appears opaque, but becomes transparent at the temperature of melting, which can be very exactly determined. Test experiments with chloral hydrate, urea, phthalimide and phthalic acid gave good results. The melting-point of the last-named substance, for which varying results have been given by different observers, is found by this method to be 203° for both the crystallised and the powdered acid. T. H. P.

1038. *Latent Heat of Vaporisation.* **W. Louguinine.** (Archives des Sciences, 9. pp. 5–26, Jan., 1900. See also Soc. Franç. Phys., Bull. 139. pp. 1–2, 1899.)—The author has measured the specific heat and heat of vaporisation of certain organic liquids, by the usual apparatus for the method of mixtures, with certain modifications in detail, which are fully described. He finds that acetonitril, propionitril, capronitril, benzonitril, pyridine, piperidine, and acetophenone follow Trouton's law closely, giving for the molecular latent heat ÷ absolute boiling-point values between 19·44 and 20·62. Metacresol gives 22·86, acetic acid, 13·74. From the behaviour of the nitrils the author concludes, contrary to the opinion of Ramsay and Shields, that they consist of simple molecules. R. A. L.

1039. *Absolute Mercurial Thermometry.* **S. A. Sworn.** (Roy. Soc., Proc. 66. pp. 86–91, March 3, 1900. *Note on this paper.* **A. Schuster.** Roy. Soc., Proc. 66. pp. 92–94, March 3, 1900.)—Comparison of six thermometers is made to study the effects of capillarity, and to determine the relation between the readings of thermometers of English flint glass and the hydrogen scale, the latter being done indirectly by comparison with thermometers of "verre dur," and of Jena 16^{III} glass. It was concluded that the capillary constant is a constant not affected by a change in the rate of rise in temperature; also that the conditions of pressure and temperature in a hypsometer are oscillatory, so that all the steam indications of a thermometer are what occur with a receding meniscus; and that the flint-glass thermometers give indications which are practically identical with those of the hydrogen thermometer.

Schuster does not think the first two conclusions true, so that the third, which depends on Sworn's method of reducing all readings to those with a *falling* meniscus, cannot at present be accepted as final. R. E. B.

1040. *Resistance of Platinum and Temperature.* **C. Raveau.** (Soc. Int. Élect., Bull. 16. pp. 410–429, 1899.)—This is an address on platinum thermometry with headings: (1) Constancy of platinum thermometers; (2) Thermometry of precision; (3) Platinum resistance at very high and very low temperatures. It contains a *résumé* of the work done in this connection by different observers. R. E. B.

1041. *Automatic Thermostats of Precision.* **E. Bose.** (Zeitschr. Instrumentenk., Beib. 19. pp. 169–171, 20. pp. 181–183, 21. pp. 189–191, 1899.)—The action of a thermostat depends on variations not only of temperature but also of pressure; for a variation *h* of the height of a liquid, of total volume *v*, apparent expansibility α and compressibility β, in a fine tube of section s, may be produced either by a change of temperature $\tau = hs/v\alpha$ or by a change of pressure $\pi = hs/v\beta$: the equation therefore connecting these variations, viz. :—

$$\tau = \pi\beta/\alpha,$$

where π represents the variation, over which we have no control, of the atmospheric pressure during an experiment, may be taken as defining the sensibility of the instrument which thus depends on α/β and not on α simply. Calculations for nine liquids of small specific heat show chloroform and CS_2 as coming next in order to Hg, but with only $\frac{1}{8}$ of its sensibility, while alcohol is at the bottom of the list with $\frac{1}{15}$ of the sensibility of Hg.

It is then shown that it is advantageous to place the regulating part of the thermostat where the interchanges of heat are the greatest and to cover the remainder with felt or other non-conducting coatings; also that the flame should not be too large, and thereby cause quick heating and slow cooling, and thus a maximum of variation, or too small, and thus prolong the period of variation; and it is finally pointed out that defective tightness of joints is responsible for many failures of thermostats. R. E. B.

1042. *Adiabatics of Crystallisation.* **G. Tammann.** (Ann. d. Physik, 1. 2. pp. 275–289, Feb., 1900.)—If in a vessel containing a mixture of solid and fused crystals in a state of equilibrium the pressure is suddenly changed, there will be first a fusion or crystallisation at the expense of the heat furnished by the adiabatic process. This will be followed by a further change of pressure due to the tendency of the system to adapt itself to the new conditions of equilibrium. The latter change of pressure depends upon the efflux of heat, and must therefore proceed much more slowly than the former, which is solely determined by the maximum rate of fusion or crystallisation. If the change of temperature per unit adiabatic change of pressure is greater than for the crystal, or *vice versâ*, and both are greater than the corresponding change in the melting-point, a rapid increase of pressure will be followed by a rapid rise of temperature and rapid fusion. The pressure would then rise further, pass through a maximum, and fall back to the original pressure of equilibrium owing to the efflux of heat. There are four other possible cases. E. E. F.

1043. *Thermokinetic Properties of Solutions.* **L. Natanson.** (Zeitschr. Phys. Chem. 30. pp. 681–704, Dec. 30, 1899. Translated from Rozprawy Wydz. M.P. Akad. Um. w. Krakowie 35. See also Acad. Sci. Cracovie, Bull. 37. pp. 349–359, 1899.)—As in a former paper (see 1899, Abstract No. 1324) the author's 'thermokinetic principle' is applied to the case of a pure substance in contact with a solution consisting of two components on the assumption that there is no friction either at the surface of contact or within either body. The only irreversible process in the system thus consists in the mutual diffusion of the components of the solution. An equation is first formed from consideration of the variations of the kinetic energy (a velocity potential being assumed) and free energy for arbitrary small displacements of the components of the system due to both mechanical and chemical causes, and also of the work done against external pressure and possible gravitative forces, and of the heat dissipated by diffusion without alteration of temperature, account being taken of the conditions to which the system is subject, and 48 simpler equations are deduced from it, one general result of which is that the external pressures must all be normal.

If the pure substance is the same as one of the components of the solution, much simplification results, and the laws of the possible thermokinetic processes are contained in the equation—

$$\mathrm{E} - e + \frac{\partial}{\partial \mathrm{P}}\mathrm{PF} - \frac{\partial}{\partial \rho}\rho' f + \Psi - \psi + \tau = 0,$$

with

$$\mathrm{E} = -(\partial\Phi/\partial t) + \tfrac{1}{2}\left\{(\partial\Phi/\partial\mathrm{X})^2 + (\partial\Phi/\partial\mathrm{Y})^2 + (\partial\Phi/\partial\mathrm{Z})^2\right\}$$

and e is a similar function of ϕ, t, x, y, z; Φ, P, F, Ψ being the velocity-potential, density, free energy per unit mass and force-potential of the pure substance at the point (X, Y, Z), and ϕ, ρ, f, ψ, the corresponding magnitudes for this component in the solution at (x, y, z), ρ' being the density of the solution, and τ a function depending on the co-efficient of diffusion and the relative momentum of the other component of the solution.

The equations are then modified for the case of a liquid A separated from a solution with A and B as components by a membrane impermeable by B, and from these it follows that the pressure of the pure liquid A is equal to the partial pressure of A in the solution, so that there must be an osmotic pressure equal to the partial pressure of B in the solution, van't Hoff's theory thus obtaining thermodynamical support. Further, every solution with two components (*e.g.*, mixtures of alcohol and water) may theoretically be considered as having *two* osmotic pressures. R. E. B.

1044. *Radiation of Black Bodies and Platinum.* **O. Lummer** and **E. Pringsheim.** (Deutsch. Phys. Gesell., Verh. 1. 12. pp. 215–230, 1899.)—In continuation of their previous researches [see Abstracts Nos. 761 (1898) and 1482 (1899)], the authors further investigated the distribution of energy in the spectrum of a black body. One of the series of measurements was made with the object of extending the spectrum in the direction of the longer waves. In this case the back wall of the hollow cylindrical space did not consist of a simple partition, but of a bundle of small porcelain tubes. The range of temperatures was over 1,000° (621 to 1646), and the wave-lengths ranged from 1,000 to 6,000μ. Wien's laws, according to which the wave-length of the maximum radiation is inversely proportional to the absolute temperature, and the corresponding maximum energy proportional to the fifth power of the absolute temperature, were confirmed. It was also found that his formula for the distribution of energy in the spectrum

$$\mathrm{E} = \mathrm{C}\lambda^{-5}\, e^{-\frac{c}{\lambda\tau}}$$

renders the observations with fair accuracy, especially at the lower temperatures. At higher temperatures certain systematic differences are observed, which may or may not be due to imperfections in the apparatus. In the case of bright platinum surfaces the calculated energy coincides with the actual energy at the maxima, but falls off more rapidly than the latter at the neighbouring wave-lengths. The maxima of the platinum curves advance with the absolute temperature according to a power somewhat smaller than the sixth.

E. E. F.

1045. *Temperatures of Incandescent Solids.* **O. Lummer** and **E. Pringsheim.** (Deutsch. Phys. Gesell., Verh. 1. 12. pp. 230–235, 1899.)—The laws of radiation for black bodies and for bright platinum place at our disposal a new means of determining the temperatures of sources of light. The temperature of a perfectly black body is given by the wave-length of the maximum energy of radiation in accordance with the equation

$$\lambda_m \mathrm{T} = 2940.$$

If this equation admits of extrapolation, it can be used for determining the temperature of any given black body. Further, we know that the radiation of any body possessing a continuous spectrum can be made equal to that of a perfectly black body by enclosing it in a perfectly reflecting envelope. If, therefore, the temperature of a luminous body is to be found, it should be brought into the centre of a good reflecting hollow sphere silvered on the inside, which allows the radiation to fall through a small opening on to the slit of a spectrobolometer. Then the wave-length of the maximum of energy is determined, and the absolute temperature T is put equal to $2940/\lambda_m$. In practice, the radiating surface will have to be made so large that only itself, and not a portion of the reflecting wall, contributes to the beam measured. Any rise of temperature occasioned by the enclosure may, as a rule, be ascertained by some differential method. Since bright platinum obeys Wien's laws of radiation very closely, it is probable that in many cases the body may not have to be converted into a "black" one. For bright platinum, the constant in the above equation would be 2630, and for most other bodies it would have an intermediate value. E. E. F.

1046. *Apparatus to show Boyle's Law.* **W. J. Humphreys.** (Phys. Rev. 10. pp. 123–125, Feb., 1900.)—The apparatus consists of a U-tube, one limb of which is open, the other closed above and below by three-way glass taps. The volume of air is determined by weighing mercury, and an accuracy of 1 in 1000 is obtainable. R. A. L.

1047. *Molecular Volumes.* **C. M. Guldberg.** (Zeitschr. Phys. Chem. 32. pp. 116–126, Feb. 6, 1900. From the Festschrift der Universität Christiania.)—The author maintains that there exists a value for the volume of a substance, which is independent both of temperature and pressure. It corresponds to the smallest volume which a body can occupy, and may be determined in two ways. When the pressure is gradually increased, the volume tends towards a limiting value which is independent of temperature. When the temperature approaches absolute zero, the volume of a body tends towards a limiting value which is independent of pressure.

First Method.—The characteristic equation may be written in the form: $\frac{p}{\mathrm{RT}} = \frac{1}{v-u} - x$, when u and x are unknown functions of volume and temperature. Assuming that, when p is very large and simultaneously v very nearly equal to u, x is not large, the latter may be neglected under these conditions and we have: $\frac{p}{\mathrm{RT}} = \frac{1}{v-u}$. Having arrived at the conclusion that u (the value of v for $p = \infty$) is independent of temperature, the author writes $u = v_0$, $\frac{p}{\mathrm{RT}} = \frac{1}{v-v_0}$, and shows how limiting values may be calculated between which v_0 must lie. In this way limiting values of v_0 are calculated for a number of organic liquids, from the results of Amagat's compressibility measurements (Annales de Chim. et de Phys. 29, 1893).

Second Method.—The author has previously shown (Christiania Videnskabsselskabs forhandlinger, 1869) that the thermal expansion of many liquids can be expressed by a formula of the type $\frac{v}{v_0}=f(\tau)$, where f denotes a function of constant form and $\tau=\frac{T}{T_2}$, where T_2 is a fixed temperature for each body. If a and a_0 denote the expansion-coefficients at T and at absolute zero respectively, the author finds that his previous investigations may be summarised by the empirical formulæ: $a=\frac{a_0}{\sqrt{1-\tau}}$, $a_0T_2=0{\cdot}450$. By definition, $\frac{1}{v}\frac{dv}{d\tau}=aT_2$, hence $\log\frac{v}{v_0}=2a_0T_2(1-\sqrt{1-\tau})$. Now for many liquids $T_2=T_1$ (critical temperature), so that $a_0T_1,=0{\cdot}450$. Thus from corresponding values of a and T we can calculate v_0. The author gives a table of the values of v_0 calculated in this way for the liquids referred to above. The table also includes the values of v_0 calculated from formulæ given by de Heen. The two sets agree very well, and the values lie between the limiting values obtained from the compressibilities. It is pointed out that there are liquids for which T_2 is considerably greater than T_1, the value of a_0T_1 being only 0·333 in these cases. The paper concludes with tables which contain the critical temperature, the molecular volume at absolute zero, and the density at the same point, for a large number of liquids. F. G. D.

1048. *Thermal Conductivity of Mixtures.* **C. H. Lees.** (Phil. Mag. 49. pp. 286–293, March, 1900.)—Attempts have been made to express the conductivity of a mixture as: (i.) The weighted mean of the conductivities of the components; (ii.) The reciprocal of the weighted mean of the resistivities of the components. By considering all the available data the author shows that the latter formula is better than the former, but is far from satisfactory. Logarithmic interpolation gives slightly closer results, but is still far from good enough for practical use. R. A. L.

1049. *Corresponding States.* **K. Meyer.** (Zeitschr. Phys. Chem. 32. pp. 1–38, Feb. 6, 1900.)—This paper is an extract from an essay to which the Danish Academy of Science awarded a gold medal. The authoress concludes that (1) the want of correspondence between van der Waals' theory and the results of experiment is not due to uncertainty as to the critical data, but arises from inexactness in the theory itself, (2) the theory may perhaps hold if, in addition to the pressure, volume and temperature of each substance being measured in special units, they are measured from special zeros; that is, that there may possibly be a general characteristic $f(\pi,\omega,\theta)=0$, where—

$$\pi=\frac{p-p_o}{p_c-p_o},\qquad \omega=\frac{v-v_o}{v_c-v_o},\qquad \theta=\frac{T-T_o}{T_c-T_o},$$

p_o, v_o, T_o being special for each substance (as are p_c, v_c, T_c) and not necessarily being 0 as taken by van der Waals.

On van der Waals' theory we may take as units of pressure, density and temperature, their values at any other corresponding points than the critical points, since $p/p'=(p/p_c)\div(p'/p_c)$, . . . and p'/p_c, . . . are constant for corresponding points. In testing the theory, therefore, the uncertain critical points were replaced by the corresponding points for which the density of the saturated vapour is 1 per cent. of that of the saturated liquid, these being determined for 20 substances, though of course with some uncertainty, by interpolation from the experimental results given by Young and his co-workers. The reduced steam-lines were then plotted, but did not coincide, as the theory requires, except in particular instances; further, expressed in these new units, the critical temperatures varied from 1·36 to 1·44 and the critical pressures from 14·7 to 16·7, the alcohols being omitted from the list.

On plotting the values of $\log(p_c - p)$ in terms of $\log(T_c - T)$ for 30 substances, where p is the saturation-pressure at temperature T, curves were obtained which, except in the case of three alcohols, water and acetic acid, displayed surprising agreement when displaced parallel to the axes so as to be superposed over each other. Corresponding points could therefore at once be determined, and it was further found that the downward shift to produce coincidence of the curves was in each case $a + \log p_c$, where a is the same for them all. This result was verified by calculation, so that p_o in the above specification of π may be taken as 0, and corresponding pressures are consequently such as are the same fraction of the critical pressures.

The values of $\log(T_c - T) - \log(T'_c - T')$ for corresponding saturation-pressures were then calculated, where the dashes refer to C_6H_5F, and were found for any substance (except the above-named five) to be constant within the errors of experiment: these give the lateral shifts of the different curves for coincidence with that of C_6H_5F, and from them were deduced the values of T_o in the above specification of θ that correspond to $T'_o = 0$. The reduced saturation-pressure curve common to all the substances was then drawn with $1 - \pi$ as ordinates and $1 - \theta$ as abscissæ.

The values of $\log(v_c - v) - \log(v'_c - v')$ for corresponding saturation-pressures, where v denotes molecular volume in the saturated liquid state, were similarly examined and found to be constant for any substance except in the neighbourhood of the critical points, this being doubtless due to uncertainty of the experimental measures; from them the values of v_o in the above specification of ω corresponding to $v'_o = 0$ were deduced. Similarly were the values of $\log(V - v_c) - \log(V' - v'_c)$ examined, where V denotes molecular volume in the saturated vapour state: these were neither very constant for a given substance nor in good agreement with the similar differences found for liquids, as the theory requires: this is ascribed by the authoress to faultiness in the difficult experimental determinations of saturated vapour densities, which, while not proving the theory, are too uncertain to be taken as disproving it.

For the unsaturated vapours of isopentane, hexane, ether and CO_2 the theory is in good agreement with experiment, those constants being assumed which were found for the saturated state; among other things excellent correspondence is found for the reduced isometric variations of p with T.

The general conclusion is that the characteristic for a fluid is of the form—

$$f(p, v + \alpha, T + \beta, a, b, c) = 0,$$

where α, β, a, b, c are constants which differ with the fluid. The exception of the alcohols, &c., is due to the polymerisation of their molecules with fall of temperature. R. E. B.

1050. *Thermodynamics.* **M. Planck.** (Ann. d. Physik, 1. 3. pp. 621–624, March, 1900.)—The author defends against the objections raised by Wesendonck (see 1900, Abstract No. 74) his contention that every natural process leading to the reduction of the total entropy of all the bodies concerned in it can be utilised for the construction of a perpetual motion of the second type, *i.e.*, a periodically active machine converting heat into work without compensation. E. E. F.

SOUND.

1051. *Velocity of Sound.* **A. W. Witkowski.** (Acad. Sci. Cracovie, Bull. 16. pp. 138–157, 1899.)—Experiments made with compressed air by Kundt's method at various temperatures and pressures show that the velocity of sound varies with the pressure, the variation being greatest at the lowest temperatures. At zero the velocity slowly rises with the pressure, being about 10 per cent. higher at 100 atmospheres than at 1 atmosphere. At 100° the velocity remains nearly the same at all pressures, while at — 130° it rapidly falls with increasing pressure. E. E. F.

1052. *Effects of Sound.* **F. Larroque.** (Comptes Rendus, 130. pp. 359–360, Feb. 5, 1900.)—To measure comparative sound intensities the author uses an electromagnetic transmitter and receiver, the latter containing a core of iron filings. The sound is reduced to silence by suitably withdrawing a portion of the core, and the silencing points of two sounds are compared. The author studies the effects of sound and music upon the circulation. E. E. F.

1053. *Mechanism of Hearing.* **F. Larroque.** (Comptes Rendus, 130. pp. 119–120, Jan. 15, 1900.)—The author studies the action upon the ear of sounds produced by the bowing of a string stretched by a vessel containing water, which slowly flows away and thus releases the tension very gradually. He finds that when the sound is conveyed to the two ears through hearing-tubes, two distinct impressions are created, and there is no interference whatever by the phase of the two sound-waves. This shows that the auditory apparatus of any one ear acts independently of the other. The author discovered a peculiar break of continuity in his right ear, amounting to $\frac{3}{19}$ of a semitone between mi_3 and fa_3. He thinks that some of the Corti fibres have been accidentally broken, and looks forward to a future microscopic verification of his supposition. E. E. F.

1054. *Movements of Expired Air during Speech.* **E. Gellé.** (Comptes Rendus, 130. pp. 358–359, Feb. 5, 1900.)—Detailed study of the different vowels and consonants, and the corresponding currents and counter-currents of air. It is concluded that the intrabuccal column of air is not inert and that the buccal cavity does not act as a resonator as it is usually said to do. It is the air itself which, by its alternate condensations and dilatations which result from the action between the currents, produces the sub-vowels along with the laryngeal sound. A. D.

ELECTRICITY.

1055. *Electric Units.* **J. A. Fleming.** (Electrician, 44. pp. 324–326, Dec. 29, 1899; pp. 366–368, Jan. 5, and 402–404, Jan. 12, 1900.)—The author endeavours to formulate proposals for the revision of the electrical units so as to make them more clear and rational, and at the same time produce as little practical disturbance as possible in the way of altering existing instruments. He is generally guided by the principles of Heaviside, whose ideal system he approximates to as closely as possible. He points out that the power under which 4π enters as the multiplying factor to convert Heaviside reckoning into B.A. reckoning is in every case, except that of magnetic force and magnetic pole-strength, the same as the power under which the dimension of magnetic permeability makes its appearance in the dimensional expression. This remarkable fact supplies at once the clue to a modification of a suggestion made by Fessenden that the rationalisation of our present units can be effected by changing the unit in which we reckon magnetic permeability. If the magnetic permeability of ether is taken to be 4π units instead of unity, we rationalise at one stroke all our present units except the units of magnetic force and pole-strength. The author proposes the following modified system of units: "(i.) Let the permeability of the ether or air be considered to be 4π units absolutely, and not units as in the present system. (ii.) Let the unit magnetic pole be $1/4\pi$ times the present c.g.s. pole. This disturbs no one, because no practical electrician ever requires to measure a pole-strength in absolute measure. (iii.) Let the unit of magnetic force be the dekampere-turn per centimetre = 10 ampere turns per centimetre = 4π times the present c.g.s. unit. (iv.) Let the unit of electric current be the present dekampere, and let it be called the ampere, or the new ampere. (v.) Let the unit of electric quantity be the present dekacoulomb, and be called the coulomb. (vi.) Let the unit of electric resistance be the present deciohm, or 0·1 ohm, and let it be called the ohm. (vii.) Let the unit of inductance be the present deci-henry, and let it be called the henry. (viii.) Let the unit of magnetic flux be the present c.g.s. unit or "one line of force" as at present used. (ix.) Let the unit of electromotive force be the present volt. (x.) Let the unit of magnetic potential difference or magnetomotive force be the present dekampere-turn or 10 present ampere turns. (xi.) The unit of power will then be 10 of the present watts and the unit of energy 10 of the present joules. (xii.) The unit of capacity will then be the present dekafarad (10 farads), and will be too large for practical use; but a fraction of it will have, as at present, to be employed, say one ten-millionth."

The above system of units is a rational system. In equations for expressing the relations of these units 4π appears only in its proper place, and the present practical system of electrical and magnetic measurement is not to any sensible extent disturbed.

The author further points out that probably all electric and magnetic phenomena can be simply described and discussed in terms of ten specific and integral quantities.

"Of the ten specific quantities, five are magnetic and five electric. The gaussivity (magnetic force), in consequence of the permeability or susceptibility of the material or medium, produces in it flux or magnetisation. Magnetisation can only occur in ferromagnetic matter; flux can occur in any substance, or even in free ether. The voltivity (electric force), in consequence of permittivity (specific inductive capacity) or conductivity of the material or medium, produces in it displacement or conduction. Conduction can only occur in certain materials (metals, electrolytes, &c.); displacement can occur in any substance, or even in free ether." E. E. F.

1056. *Electric Units.* **R. A. Fessenden.** (Elect. World and Engineer, 35. pp. 282–284, Feb. 24, 1900.)—The author discusses the desirability of a change in the existing units, and while considering those proposed by Fleming (see preceding Abstract) as very convenient and simple, would prefer to have absolute rather than "practical" units, and would distinguish electrostatic from electromagnetic units by the prefixes *sta* and *ma*. To go ahead with the present absolute and practical units would mean a loss of time of about three-quarters of a year for every electrical engineering graduate, and the perpetual annoyance of a complicated, irrational, and vexatious system of reckoning. (See also 1900, Abstract No. 643). E. E. F.

1057. *Transformations of Conducting Networks.* **J. Herzog** and **C. P. Feldmann.** (Elektrotechn. Ztschr. 21. pp. 167–171, March 1, 1900.)—The problem of current distribution in a conducting network when treated analytically leads to a system of linear equations. The solution may frequently be simplified by effecting various transformations which reduce the number of conductors in the network. The author considers the following transformations: (1) The replacement of a number of impedances joined in series by a single impedance; (2) the replacement of a number of parallel impedances by a single impedance; (3) the replacement by a single impedance of a system of two conductors which are bridged over by others at certain intervals; (4) the replacement of a star by a △, and *vice versâ*. Examples are given to illustrate the usefulness of these transformations.

A. H.

1058. *Application of Graphical Methods to Long Transmission Lines.* **F. Breisig.** (Elektrotechn. Ztschr. 21. pp. 87–92, Jan. 25, 1900.)—The author first explains an approximate graphical method of dealing with the problem of the transmission of an alternating current along a line possessing resistance, inductance, and capacity. The approximation consists in supposing the capacity concentrated at equidistant points of the line instead of uniformly distributed as is actually the case. Assuming that the potential and current at one of the points in the line to which a capacity is attached are known, we draw two vectors to represent these quantities in magnitude and phase. In proceeding along the line, the drop of potential along the section of the line between the starting-point and the next point to which a capacity is attached is given by the product of the current and impedance of that section. Subtracting this drop vectorially from the given potential vector, we get a new vector corresponding to the potential of the next point where a capacity is attached to the line. At this point a known condenser current (determined by the known capacity and the new value of the potential just found) leaves the line. On subtracting this vectorially from the given current vector, we obtain a new current vector which gives the current in the succeeding section of the line. By proceeding in this manner we obtain a number of potential and current vectors corresponding to various points along the line. The author remarks that this method, besides not being strictly accurate, is laborious, and he next proceeds to consider the accurate graphical solution of the problem; this, however, involves certain results of analysis. The loci of the extremities of the potential and current vectors are represented by spirals. In the concluding part of the paper the author describes a model by means of which the propagation of current along a line may be ingeniously exhibited. The model consists of a series of eccentrically mounted discs, the amount of eccentricity of any disc depending on the current amplitude at the corresponding point of the line, and the angle of advance of each elementary eccentric corresponding to the phase of the current. The discs are sufficiently numerous to present a practically continuous surface. Their shadow is projected on a screen, and when the discs are rotated the varying outline of their shadow shows the manner in which the current changes along the line both as regards amplitude and phase. The zero line is given by two concentrically mounted discs at the ends of the shaft carrying the discs.

A. H.

1059. *Energy of Electric Currents.* **A. Pérot.** (Écl. Électr. 22. pp. 5–13, Jan. 6, 1900), also **A. Potier** (Écl. Électr. 22. pp. 81–83, Jan. 20, 1900.)—In the first article Pérot aims at reducing to a minimum the number of experimental laws which must be regarded as indispensable to the establishment of the known laws of currents. Reversing the usual order of procedure, he starts from the laws of the induction of electromotive forces and hence deduces an expression for the potential energy of a current system. From this he deduces the laws of the production of magnetism by currents, and also the law of Biot and Savart relating to the mechanical force or conductors conveying a current in a magnetic field. The modifications caused by variable permeability and magnetic hysteresis are considered. The second article, by Potier, criticises Pérot's expression for the potential energy and gives reasons showing that it is not sufficiently general. W. E. S.

1060. *Diurnal Variation of Atmospheric Electricity.* **A. B. Chauveau.** (Journ. de Physique, 8. pp. 599–608, 1899.)—Although thirty different theories of atmospheric electricity have been proposed, the number of well-ascertained facts concerning it is exceedingly small. What the old physicists called the "soft electricity of fine weather" is now recognised as the most important factor in the phenomena. It is generally known that the earth's surface has a permanent negative charge, and the upper regions of the atmosphere a permanent positive charge, but the distribution of potential below an altitude of 1,000 m. is as yet very obscure. The author then describes the maxima and minima referred to in Abstract No. 70 (1899). Tropical stations, such as Batavia, hardly show the night minimum at all. The author, while pointing out the double oscillation, attributes the irregularities to the influence of the moisture of the soil. E. E. F.

1061. *Diurnal Variation of Atmospheric Electricity.* **A. B. Chauveau.** (Soc. Franç. Phys., Séances, 3. pp. 91–99, 1889.)—After discussing the maxima and minima referred to in Abstract No. 70 (1899), the author passes on to the analysis of two groups of observations, taken at Batavia. In the first group the collector was 2 m. above ground and near trees; in the second, 8 m. above ground and remote from trees and buildings. This second group shows the summer type. The material from polar regions is scanty. Eliminating the disturbed days from Lemström's observations in Finland (lat. 68°) and from S. A. Andrée's at Cape Thordsen (Spitzbergen, lat. 78°), Chauveau arrives at mean annual diurnal variations of the winter type. In the first Batavia group, at the Collège de France (Mascart), and at Greenwich, the collectors are not well placed; the summer oscillation is simple, but differs from the winter type in so far that the maximum occurs at night-time, the minimum during the day. The author concludes that some disturbing influence of the earth which is strongest during summer (chiefly negatively charged water vapour, probably) complicates the diurnal variations of the electric potential which would otherwise be characterised by a simple oscillation with a high day value and a marked minimum between 3.30 and 4.30 a.m. Winter observations on the Eiffel Tower are highly desirable.

H. B.

1062. *New Powder Mixture for Lichtenberg Figures.* **K. Bürker.** (Ann. d. Physik, 1. 3. pp. 474–482, March, 1900.)—Instead of using a mixture of minium and sulphur, the author mixes 1 part by volume of carmine, 3 of lycopodium, and 5 of flowers of sulphur. The carmine and sulphur are first thoroughly mixed and the lycopodium is added last. The figures are reversed in colour with respect to the ordinary Lichtenberg figures, as the polarity of the sulphur is reversed in the combination. The figures obtained are of striking beauty. The circles have centres and outer halves of the opposite colour. E. E. F.

1063. *Wavy Spark Discharge.* **E. Ruhmer.** (Elektrotechn. Ztschr. 21. pp. 152–154, Feb. 22, 1900.)—There are two distinct forms of discharge which are obtained by using a Wehnelt interrupter and a spark-gap between a point and a disc. At large distances apart single strong sparks cross the gap, while at short distances a curved flame crosses from the point to the disc. The author describes a peculiar form of discharge which occurs at intermediate distances. It consists of a large number of thin spark lines branching out from the point and extending towards the disc like a brush. Every one of the lines has a sinusoidal wave shape, due in reality to a spiral form of the spark-path. When the sparks are successively photographed by a mutograph it is seen that they are very similar in outline, but that they are successively displaced with respect to each other in the direction of the disc. The author does not give a theory of the phenomenon, beyond discarding the suggestion of a magnetic influence and vaguely hinting at an attraction and repulsion of two simultaneous sparks owing to differences of phase. The displacement towards the disc is, however, explained by the "electric wind" blowing from the point, which displaces the spiral chains of temporarily conducting dust and air particles towards the disc. The displacement is at the rate of about 1 m. per second. E. E. F.

1064. *Wehnelt Interrupter.* **G. Pacher.** (N. Cimento, 10. pp. 444–447, 1899; Dagli Atti del R. Inst. Veneto, 58. 2. pp. 777–785, 1898–1899.)—The author describes various experiments made with a Wehnelt interrupter fed by a strong current. Tesla and Hertz phenomena are obtained in great intensity. An interesting experiment is described in connection with Vicentini's liquid coherer. A few drops of mercury are introduced into a narrow tube, and turpentine is added to fill it up. The mixture is heated until the mercury is broken up into minute drops. On placing the tube into the focal line of the receiving mirror, a single spark from the oscillator suffices to make the mercury coalesce into a few large drops. E. E. F.

1065. *Analysis of Condenser Discharges.* **F. Richarz** and **W. Ziegler.** (Ann. d. Physik, 1. 3. pp. 468–473, March, 1900.)—The authors noticed a peculiar appearance in the curves obtained on analysing a number of successive condenser discharges by means of a Braun kathode-ray tube and a revolving mirror. The appearance is that of an unsymmetrical herring-bone (see fig. 1), each discharge being represented by two ribs, an upper and a lower one. The introduction of a high inductance proved that this is due to the superior intensity of the turning-points (see fig. 2), which coalesce into two convergent luminous lines. The centre line is the track of the fluorescent spot on the screen. E. E. F.

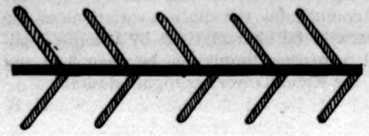


FIG. 1.

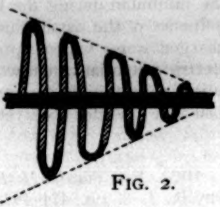


FIG. 2.

1066. *Constitution of the Electric Spark.* **A. Schuster** and **G. Hemsalech.** (Roy. Soc., Phil. Trans. 193. pp. 189–213, 1899.)—Some of the results of this investigation were announced in Abstract No. 1377 (1899). The present fuller account contains very interesting descriptions of the methods and apparatus used for photographing sparks and spark spectra on a rapidly moving film, and of the manner in which the results are interpreted; reproductions of the photographs are also given. The authors do not claim great accuracy for their estimates of molecular velocities, but are able to state generally that metals of light atomic weight, like aluminium and magnesium, are projected from the poles with greater velocities than heavier ones, such as zinc, cadmium, and mercury. The results for bismuth are not easily explained, except by assuming the presence of different kinds of molecules having different masses, the lighter ones diffusing more quickly. The method used is likely to prove of extreme value in separating the effects of different molecules.

When two lines of a metal are of unequal intensity it is not always due to the fact that at any period of the discharge the vibrations which appear the strongest are really the most intense. Our eye or the photographic film only perceives the total energy sent out, and the time of luminosity is in many cases very different for different lines. A vibration which is weak, but persists, may appear stronger than one of greater intensity which only appears for a very short time.

When a coil of wire of sufficient self-induction is introduced into the spark-circuit, the air-lines completely disappear. The explanation appears to be that the air-lines are produced entirely by the first initial discharge, when the spark-gap contains no metallic vapour. The subsequent oscillations, on the contrary, pass through the metal vapour, which meanwhile has had time to diffuse away from the electrodes. By inserting the coil, the initial discharge takes place more slowly and apparently does not heat up the air sufficiently to yield the line spectrum. The duration of the spark is considerably lengthened, and the discharge may pass through the metal vapour, which after a few millionths of a second fills the whole spark-gap. This method of removing the air-lines may prove very useful, as they are often troublesome in the investigation of spark-spectra.

Finally, the appearance of calcium lines in the photograph of the spectrum of fairly pure silver has shown the existence of a new type of spectroscopic lines, namely, one that starts in the centre of the spark and is propagated towards the poles. D. E. J.

1067. *Electric Discharge.* **P. Villard.** (Comptes Rendus, 130. pp. 125–127, Jan. 15, 1900.)—A flame placed in an electric field acts as a bundle of Röntgen rays would do, cutting the lines of force, and the gases produced by the combustion are active like Röntgenised air. In the absence of an electric field the flame is inactive and the gaseous products, transported into an electric field, produce no discharge. It is as if in ordinary air the incandescent particles gave out kathode rays, while in a field they gave out Röntgen rays; or rather analogues to these. This would explain flame discharges, discharges by incandescent bodies and phosphorus, the peculiar radiations given out by electric sparks, especially from the kathode end of the spark, discharge by ultra-violet light, the Edison effect (current between the positive end of the filament of a glow-lamp and an electrode fused into the lamp), the production of ozone by flames, incandescent bodies, the electric arc and sparks, and by the oxidation of phosphorus in the cold, and the production of ozone by radium. A. D.

1068. *Electric Discharge in Large Quantity.* **J. Trowbridge.** (Elect. Rev. N.Y. 36. p. 5, Jan. 3, 1900.)—This short note accompanies two photographs of electric discharges of very large quantities. One hundred and fifty plate-glass condensers, 18″ × 20″ × ⅛″ thick are arranged in multiple and charged to 20,000 volts by means of 10,000 Planté cells. One photograph represents the deflagration of 6 inches of No. 30 iron wire and the other the deflagration of a similar piece of wire arranged as a shunt to a spark-gap. A spark occurs at the spark-gap simultaneously with the deflagration of the wire.

The author therefore concludes that a spark might occur inside a metallic cage when large quantities are in question. A cage would not, therefore, in all cases completely protect a powder magazine against lightning.

J. B. H.

1069. *Striated Electrical Discharge.* **J. H. Jeans.** (Phil. Mag. 49. pp. 245–262, March, 1900.)—This paper, which forms an important contribution to ionic theory, is a sequel to one by Professor J. J. Thomson on the "Theory of Conduction of Electricity through Gases by Charged Ions" (see 1899, Abstract No. 1156). The solution obtained by Thomson for the discharge in rarefied gases between electrodes does not account for the striations; the present paper contains a mathematical investigation of Thomson's equations and conditions to see whether a periodic solution does not exist, which will satisfy the conditions of the luminous striated discharge.

The equations do not lend themselves to definite solution, and in the paper they are treated graphically, the different families of curves which satisfy them being drawn. The various physical conditions at the electrodes and throughout the tube are satisfied by one set of these curves which are of a periodic nature and, under certain assumptions which the author justifies, they satisfy all the known conditions of striated discharge. J. B. H.

1070. *Minimum Sparking Potential for Various Gases.* **R. J. Strutt.** (Roy. Soc., Phil. Trans. 193. pp. 377–394, Jan. 9, 1900.)—This paper deals with experiments undertaken to test the sparking potential in various gases at various pressures, between large parallel planes at a fixed distance apart. It was previously found by Peace that the sparking potential between two parallel plates in air diminished as the pressure diminished till a certain point is reached, and then began to rise rapidly. The pressure at which the sparking potential was a minimum depended on the distance between the plates, and increased as this distance was lessened. The minimum potential itself, however, varied very little with the distance between the plates. This minimum potential, as pointed by J. J. Thomson, was of the same order as the kathode fall of potential. In the experiments here described a Wimshurst machine was used as the generator of the required potential difference. Its terminals were connected to those of a fluid high-resistance column of variable length. This admitted of easy adjustment of the potential to the required nicety. To insure electrical steadiness a Leyden jar was also connected across the terminals of the machine. In series with the jar and the spark-gap was placed a telephone. The telephone indicated by a click the passage of a spark, the voltmeter being simultaneously read. A gas is found able to sustain for a short time a potential difference about three times as great as that required to produce discharge through it when this initial resistance has been broken down. This second lower value was always recorded as it was desired to compare the minimum potential with measurements of the kathode fall, in which a continuous current was passing through the gas. The paper gives curves and tables for several gases and describes the elaborate precautions taken to insure their purity. The following are values of the minimum potentials found: Air, 341 volts; hydrogen, 302 to 308 volts; nitrogen, 251 volts; helium, 261 volts. The experiments are held to establish the equality of the minimum spark potential and the kathode fall. E. H. B.

1071. *Potential Gradient in Rarefied Gases.* **G. C. Schmidt.** (Deutsch. Phys. Gesell., Verh. 1. 15. pp. 265–268, 1899.)—Measurements were made of the potential gradient in the positive light and near the kathode, of the potential gradient in dark discharges, and the variation of the total potential difference with the temperature. The current was furnished by a battery of 1,000 accumulators, and platinum probes were inserted into the vacuum tube at short distances. It was found that as the temperature rises the positive light becomes stratified, the stratifications becoming brighter and less defined as the current strength is increased. At the same time the positive light withdraws towards the anode, so that eventually the discharge becomes altogether dark. On introducing a spark-gap in the circuit, the tube lights up again, thus showing that the gas has not lost its power of luminosity, but that the discharge has assumed another form. The glow-light also experiences striking changes. When the kathode is heated, the glow-light extends, and the more so the smaller the pressure. The potential gradient in the unstratified positive light is independent of the temperature, and so is the gradient near the kathode. In the dark discharge the gradient increases with increasing current strength, and also with increasing temperature, if the density of the gas remains constant. But if the pressure remains constant, it decreases with the temperature. With increasing temperature, the total potential difference decreases at first slowly, and then more rapidly, attains a minimum, and then rises again. E. E. F.

1072. *Are Rarefied Gases Electrolytes?* **E. Bouty.** (Journ. de Physique, 9. pp. 10–17, Jan., 1900.)—J. J. Thomson's researches indicate that gases under a pressure of 0·005 mm. may behave as electrolytes. But all known electrolytes obey Faraday's law and yield at the electrodes products of decomposition proportional in quantity to the quantity of electricity passing between the electrodes. Now E. Wiedemann has studied from this point of view gaseous hydrochloric acid, and the vapours of the chloride, bromide, and iodide of mercury. He only found, especially with the last three, insignificant quantities of products of decomposition, amounting to 3 or 4 per cent. of what would be required by Faraday's law. Furthermore, the products of decomposition presented themselves almost indifferently at both electrodes. Their presence can be sufficiently explained by secondary reactions (*e.g.*, thermal actions) and Wiedemann concludes that a rarefied gas cannot be regarded as a true electrolyte. From his own experiments (see 1899, Abstract No. 1893) the author comes to a similar conclusion. He finds that the apparent conductivity of a rarefied gas is essentially connected with its luminescence: the gas luminesces wherever it permits electricity to pass. The apparent conductivity is directly connected with a phenomenon of a brusque and violent nature which follows the phenomena of dielectric equilibrium abruptly, as the rupture of a stretched wire follows its elastic equilibrium when the stretching force exceeds a certain limit. The ether in a perfect vacuum possesses perfect dielectric elasticity: we cannot break down its dielectric cohesion. But gaseous molecules introduce weak points into it, and when they are present the dielectric cohesion becomes measurable. D. E. J.

1073. *Potential Gradient in Gaseous Mixtures.* **W. Heuse.** (Deutsch. Phys. Gesell., Verh. 1. 15. pp. 269–271, 1899.)—Minute quantities of mercury vapour in hydrogen are easily discovered by means of spectrum analysis, but it is very difficult to discover traces of hydrogen in mercury vapour by the same means. Similarly, small traces of hydrogen or nitrogen are easily discovered in helium, but not the reverse. These facts lead to the question as to how the constituents of a gaseous mixture are concerned in the conduction of a current. The author has therefore studied the potential gradient in the unstratified positive glow-light in (1) nitrogen, (2) mercury vapour, (3) a mixture of both. In nitrogen, the potential gradient maintains the same value of about 37 at all temperatures between 20° and 200°. In mercury vapour, the gradient slowly rises with the temperature, but not in proportion to the pressure of the vapour. In a mixture of nitrogen and mercury which is heated up from 18° to 200°, the potential gradient falls at first, reaches a minimum of 27·3 volts at 91°, and after that it increases at the higher temperatures to a value some 10 volts greater than that due to the two constituents taken singly. E. E. F.

1074. *Repulsion of Vacuum-Tube Electrodes.* **F. Neesen.** (Deutsch. Phys. Gesell., Verh. 1. 14. p. 253, 1899.)—This is a reply to Ebert's criticism of the author's explanation. (See 1900, Abstract No. 115.) The attraction produced by the ascent of a hot stream of gas between the plates does not enter into consideration in the case of a vacuum tube, as the pressure on the outside of the plates would be negligible. As regards the second objection to the author's explanation, the author does not acknowledge that heating necessarily alters the fall of potential between the electrodes. He adheres to his former view that the apparent repulsion of the electrodes is due to the thermal expansion of the intervening gas. E. E. F.

1075. *Velocity of Kathode Rays and Electrolytic Conductivity of Gases.* **A. Battelli** and **A. Stefanini.** (N. Cimento, 10. pp. 324–337, 1899.)—The velocity of kathode rays is in any event far less than that of light; and it varies with the rarefaction of the gas. There is some reason for believing that the phenomenon is the summation of molecular displacements and etheral phenomena, either undulatory or translatory, along with chemical changes resulting in the production of ions whose velocities depend on the rarefaction of the gas and on the potentials at the electrodes. There appear to be no free ions in rarefied gas under normal conditions; but ionisation is caused by the presence of a sufficient difference of potential. A. D.

1076. *Energy Expended in Oscillating Discharges in Vacuum Tubes.* **G. Telesca.** (N. Cimento, 10. pp. 420–431, 1899.)—The ratio between the quantity of heat developed in the ordinary spark and that developed in the vacuum tube, other conditions being the same, increases with the rarefaction, with the explosive distance, with the period of oscillation and with the damping. The ratio between the amount of heat developed in the tube and that in the metallic circuit decreases as the same data increase. The ratio between the heat in the spark and that in the metallic circuit diminishes with increase in the rarefaction, in the capacity, in the damping, and in the period of oscillation, but increases with the explosive distance and with the self-induction. A. D.

1077. *Velocity of Electric Waves in Air and along Wires.* **C. Gutton.** (Soc. Int. Élect., Bull. 16. pp. 311–315, 1899.)—A linear Hertz oscillator is placed in the focal line of a parabolic mirror facing a similar mirror provided with a resonator. From the latter, two parallel wires proceed to a Branly coherer which is also connected to the oscillator by another pair of wires: the latter are longer than the first pair and their length can be varied. The distance between the focal lines of the mirror is 5·4 metres. The wires from the oscillator are crossed and their length is adjusted so that no effect is produced on the Branly tube. The mirrors are now brought 4 metres nearer each other, and the velocities in air and along the wire are compared by finding what length has to be added to the pair of wires proceeding from the resonator to the tube in order to compensate for the shortening of the distance traversed in air. It is found that no effect is produced on the Branly tube when the increase of length is 4 metres. Thus the velocities in air and along wires are equal.

The method can be used for comparing the velocity in air with that in a given dielectric by introducing a plate of the latter between the mirrors. (See also 1899, Abstract No. 1498.) D. E. J.

1078. *Hertz Wave-Receiver.* **F. J. Jervis-Smith.** (Nature, 60. p. 436, 1899.)—In the suspended system of a d'Arsonval galvanometer of 500 ohms resistance, a small projecting Branly receiver is introduced. The galvanometer is connected in series with a resistance of 16,000 ohms and a single dry cell. On receipt of electric waves the Branly receiver becomes conducting and the galvanometer deflection indicates the fact. At the same time decoherence is automatically caused by a projecting knob on the centre of an elastic disc kept vibrating by a jet of water. The coherer is brought up against this knob at each deflection so that coherence is immediately followed by decoherence. The author found that less than $\frac{1}{16}$ of a milliampere was sufficient to give a deflection. E. H. B.

1079. *Flames Containing Salt Vapours.* **H. A. Wilson.** (Roy. Soc., Phil. Trans. **192.** pp. **499–528, 1899.** See also **1899,** Abstract No. **1722.**)—Conductivity of flames is similar to that of Röntgenised gas (Roy. Soc., Proc. **64**. p. 142). The saturation value of the current as the E.M.F. is increased depends on the temperatures of the electrodes, and not on the motion of the flame-gases. The current is always greater when the hotter electrode is negative than when it is positive. When both electrodes are at a bright red heat, the upper electrode being positive, the fall of potential is very similar to that observed in gases at low pressures; a rapid fall of potential near each electrode and an approximately uniform small potential gradient in the intervening space. When the upper electrode is negative, nearly all the fall of potential occurs near this electrode. When the two electrodes are both kept hot, the saturation current is independent of the distance between the electrodes, whereas if the salt vapour were ionised throughout the flame the current should have increased with the distance between the electrodes. There is a small amount of such ionisation throughout the flame, but this is only a small fraction of that observed when the electrodes are both hot enough to glow: and unless the salt vapour actually comes in contact with the glowing electrodes, the conductivity of the flame is not affected by its presence. The ionisation of the salt vapour occurs almost wholly at the surfaces of the glowing electrodes. When a hot air stream was substituted for the flame, the current was zero up to about 25 volts for 1 cm. distance, after which it increased uniformly with the P.D. The necessary P.D. increased more rapidly than the distance, except when this was less than about 1·5 cm.: and for small variations the necessary P.D. varied directly as the velocity of the air-blast. Increasing the temperature increased the amount of current obtained, and diminished slightly the least necessary P.D., and also diminished the least distance at which satisfactory results could be obtained. The velocities of negative ions were 26 cm./sec. for 1 volt/cm., of positive ions of salts of Li, Na, K, Rb, and Cs 7·2, and of positive ions of salts of Ba, Sr, and Ca 3·8. The velocities in hot air are much smaller than those in the flame, about one-fortieth, the respective temperatures being about 1,000° and 2,000°. The velocity of negative ions in the flame, 1,000 cm./sec., is of the same order of magnitude as the theoretical velocity of an ion consisting of one atom. That other velocities are less than this shows that the ions consist of clusters of atoms (assuming that they carry the same charge as the ions in electrolysis of solutions), which clusters are larger in positively than in negatively charged ions. The size of the cluster of atoms forming a gaseous ion depends, at a given temperature, only on the charge on the ion. Those ions which have equal charges also have equal velocities in the same medium. Under the slope of potential at the surface of the electrodes the negative ions, having higher velocities, are more easily dragged away than the positive ions; so that unless the slope of potential is great enough, a given slope of potential at the electrode will cause a greater current when the electrode is negatively than when it is positively charged. If one electrode be hot, the other cool, there will be only one kind of ion between the electrodes: this will diminish the potential slope near the hot electrode, and *vice versâ*. If both be hot, the positive ions travelling more slowly accumulate in the gas and affect the fall of potential, which becomes more rapid at the negative than at the positive electrode, with the consequence that the more mobile negative ions may mainly carry on the current, but the current carried by the positive ions continues to increase nearly uniformly with the E.M.F. If the positive electrode alone be hot, the fall of potential is transferred to the negative electrode; the negative ions are dragged out, and so far as the negative ions are concerned the current attains its saturation value; but the current will be much smaller than when the negative electrode is hot. There is a very close analogy between the conductivity of salt vapours in flames and the conductivity of gases at low pressures. In both cases there is a greater fall of potential near the negative than near the positive electrode, with a small slope of potential in the intermediate space; and probably the peculiar form of the fall of potential in gases at low pressures is due, like that in the flame, to a great difference between the velocities of the positive and negative ions. A. D.

1080. *Deformation of Polarised Dielectrics.* **P. Duhem.** (Journ. de Physique, 9. pp. 28–30, Jan., 1900.)—In 1892 the author showed how the principle of virtual velocities should be applied to polarised dielectrics or magnetic media. The method used appears to be valid, but unfortunately an error slipped into the calculations: in estimating the virtual variation of the dielectric or magnetic potential a quantity was neglected as being infinitely small and of the second order, whereas it was really of the first order. On account of this error the conditions of equilibrium given for different points of the limiting surface of a polarised medium were incorrect, but the conditions within the interior of the magnetic or dielectric mass were correct. The error was pointed out by Liénard, who evaluated the neglected term and gave a correct theory of the pressure within polarised media. This theory shows one remarkable peculiarity. In order to maintain a polarised fluid in equilibrium it is necessary to apply to each element of its limiting surface a pressure whose direction is normal to the element, but whose magnitude depends on the orientation of the element. The magnitude at any point is $2\pi\epsilon M^2 \cos^2 (M, N)$, ϵ being the constant of Coulomb's laws and M the intensity of polarisation. When the body is polarised so feebly that we can neglect its potential on itself this pressure introduced by Liénard becomes proportional to the square of the intensity of the field and *to the square of the coefficient of polarisation of the body*. All the other terms for the pressures produced by polarisation are proportional to the square of the intensity of the field and *to the first power of the coefficient of polarisation.* The terms introduced by Liénard may therefore be neglected in the case of feebly dielectric or magnetic bodies: for such bodies the theory given by Duhem holds good. On the other hand the complementary term becomes very important in the case of strongly magnetic bodies, such as soft iron. D. E. J.

1081. *Comparing Self-inductances.* **H. V. Carpenter.** (Phys. Rev. 10. pp. 52–62, Jan., 1900.)—The two coils whose self-inductances are to be compared are connected in parallel, and in series with one of them is a non-inductive resistance. Apply to their common terminals a harmonic potential difference. The currents in the two coils will be in phase if the time constants of the two branches thus formed are the same. This can be attained by varying the non-inductive resistance, which is obviously put in series with the coil of greater time constant. The ratio between the self-inductances of the coils will be equal to the ratio between the resistance of the two branches when the currents are in phase.

The paper describes two methods of determining when the currents in the two branches are in phase, one method by means of a telephone in series with two coils which act as secondaries to the coils to be compared, these secondary coils being connected so that their induced E.M.F.'s are in opposition. In the second method the telephone is replaced by a modification of the Siemens dynamometer. E. C. R.

1082. *Measurements on the Microphone.* **J. Cauro.** (Soc. Franc. Phys., Séances, 3 pp. 112–115, 1899.)—When a sound wave strikes the microphone the current i becomes $i' = i(1 + \alpha + \beta)$, where α is a continuous variation and β is an alternating variation having the same period as the sound. The effective fraction of the alternating variation of the primary current is independent of that current and is less than $\frac{1}{5}$. M. O'G.

1083. *Influence of the Dielectric upon Resistance.* **E. Drago.** (N. Cimento, 10. pp. 447–450, 1899; Atti Acc. Gioenia di Catania, vol. 12, ser. 4.)—German-silver wire was tested for the alleged influence of the dielectric upon the resistance described by Sanford in 1892 (see Phys. Soc. Abstracts, No. 34, 1896). The dielectric used was petroleum. No such effect as alleged was observed, and the author concludes that it does not exist, or is too small to be detected. E. E. F.

1084. *Specific Resistance of Nickel.* **J. A. Fleming.** (Roy. Soc., Proc. 66. pp. 50–58, March 3, 1900.)—Mathiessen's determinations of the specific resistances of various metals made in 1860 to 1865 are usually shown to be correct within very narrow limits by more recent experiments. For nickel his value of 12,320 c.g.s. units at 0° C. is usually assumed. Recently the author has made a special investigation of the specific resistance at temperatures ranging from $-182°$ to $+95°$ C. of a nickel wire 250 cm. long and 0·02567 cm. in diameter prepared electrolytically from a purified solution of nickelous chloride and annealed in hydrogen. The results are tabulated and plotted as a curve which tends as usual to pass through zero at the absolute zero of temperature. The specific resistance thus determined is only 6,935 c.g.s. units at 0° C., and the mean temperature variation is 0·00618. between 0° C. and 100° C. The discrepancy is probably due to some impurity in Mathiessen's specimens. L. B.

1085. *Electrical Resistance between Opposite Edges of a Symmetrical Quadrilateral Sheet.* **C. H. Lees.** (Manchester Lit. and Phil. Soc., Mem. 44. 1. pp. 1–8, 1899–1900.)—By means of a transformation theorem given by Maxwell the author transforms the stream and equipotential lines of the quadrilateral sheet in question to those of an equivalent square, whence the resistance required immediately follows. E. H. B.

1086. *Polarisation and Resistance of the Copper Voltameter.* **B. E. Moore.** (Phys. Rev. 10. pp. 34–51, Jan., 1900.)—The author describes various experiments with the copper voltameter, showing the change of polarisation with time, using both closed and open circuits. Measurements of the polarisation are given for times varying from 0·00006 to 0·045 second after the removal of the polarising E.M.F., the copper sulphate solution being kept at a constant density (1·1395). The results of the experiments, which are given graphically, indicate that the current first produces a change at the surfaces of contact of the solution and the electrodes, the amount of this change increasing, and thicker layers of the solution being affected as time goes on. The diffusion which takes place in the liquid opposes the increase of polarisation, and finally causes it to vanish. When the current is small and the layer of liquid affected by the concentration changes is consequently small in width, the polarisation decreases very rapidly; for stronger currents, with which the changes in concentration of the solution spread farther from the electrodes the polarisation diminishes less in a small interval, and the values obtained for the true resistance correspond more nearly with the values obtained when alternating currents are employed. T. H. P.

1087. *Electrolytic Interrupter for Feeble Currents.* **A. v. Rzewuski.** (Ann. d. Physik, 1. 3. pp. 614–616, March, 1900.)—If it is the oxygen accumulating at the anode which prevents the electrolytic interrupter from working with weak currents, any process which counteracts that accumulation must lower the minimum of E.M.F. required. A violent motion of the active electrode effects this. But better results are obtained by directing a current or jet of dilute acid against the electrode, the necessary pressure being obtained by raising the reservoir about a yard above the interrupter. With such an arrangement 24 volts suffice to obtain a uniformly interrupted current of great steadiness. When the pressure of the acid is too high the current becomes continuous. An incidental advantage is that the current of acid keeps the apparatus cool. E. E. F.

1088. *Durable Wehnell Interrupter.* **R. H. Cunningham.** (Elect. Rev. N.Y. p. 7, Jan. 3, 1900.)—The brass rod bearing the platinum anode is encased in hard rubber tipped with a lava bushing. The kathode consists of a coil of lead tubing through which cold water is circulated. E. E. F.

1089. *Comparison of Different Forms of Wehnell Interrupter.* **A. Turpain.** (Comptes Rendus, 130. pp. 409–412, Feb. 12, 1900.)—Foucault's interrupter and various forms of Wehnelt interrupter are considered. The Wehnelt form with a long wire of platinum renders the interruptions irregular, and the interrupter is not durable. The modifications of the Wehnelt interrupter described by Caldwell and Simon are next mentioned (See Elec. Rev. N.Y. 34. p. 311, 1899; and S. A. 1899, Abstracts Nos. 1918 and 1919). By arranging three vessels of unequal size one inside the other, pierced with holes, excepting the exterior vessel, and containing each an electrode formed of a sheet of lead, an interrupter is obtained which can work with variable potential differences. The experimental facts observed show clearly that electrolysis plays no part in the working of the interrupter with platinum wire, or of that with holes pierced through a test tube.

The author concludes that from the point of view of *durability* and *economy* the Wehnelt interrupter with orifices (like that described by Simon, see 1899, Abstract No. 1919) is to be preferred to that with platinum wire. Both are preferable to that of Foucault, both from the above point of view, and from those of *convenience* and *rapidity*. As to *regularity* and *power* within the limits of speed between which it works, the interrupter of Foucault does not yield to that of Wehnelt. It allows, moreover, of the variation at will of the number of interruptions per second. J. J. S.

1090. *Inversion of the Hepta- and Hexa-hydrates of Zinc Sulphate in the Clark Cell.* **H. T. Barnes.** (Journ. Phys. Chem. 4. pp. 1–20, Jan., 1900.)—The conversion of $ZnSO_4.7H_2O$ into $ZnSO_4.6H_2O + H_2O$, which takes place at 39°, leads to a break in the curve representing the variation of the E.M.F. of a Clark cell with temperature (Callendar and Barnes, Proc. Roy. Soc. 62. 150, 1897). Using the B.O.T. "Crystal" cell, it was found that the hexahydrate crystals did not persist in a metastable condition below 30°, whereas in the old form of cell with an excess of solution and few crystals the hexahydrate could be preserved as low as 0°, leading of course to abnormal values for the E.M.F. of a cell which had been heated above 40°; the reverse change of the heptahydrate to hexahydrate occurred at about 42°. The heptahydrate branch of the curve, which has been traced up to 42°, is represented for a mean temperature of 39° by the formula—

$$E_t - E_{39} = -1{\cdot}635\,(t-39) - 0{\cdot}0140\,(t-39)^2,$$

whilst the hexahydrate branch, which has been traced down to 30°, is represented by—

$$E_t - E_{39} = -1{\cdot}000\,(t-39) - 0{\cdot}007\,(t-39)^2\,;$$

the exact point of intersection of the two E.M.F. curves is 38·78°. The transition point of zinc sulphate, as determined from the intersection of the solubility curves of the two hydrates is nearly a degree higher, viz., 39·95°; the difference is probably due to the lowering of the transition-point of the zinc sulphate by the mercurous sulphate present in the Clark cell.

Above 35° the Clark cell appears to undergo a secondary change, causing the E.M.F. to fall off more rapidly than at lower temperatures. In preparing the zinc sulphate for the "Crystal" cell, it has been noticed that if the saturated solution be treated with mercurous sulphate above 35° a yellow turbidity appears on cooling, which does not appear if the temperature does not rise above 30°; this observation is probably associated with the more rapid falling off in the E.M.F. of the cell at these temperatures.

[*Cf.* Jaeger, Wied. Ann. 63. p. 354, 1897; Abstract No. 811 (1898).]

T. M. L.

1091. *E.M.F. of Clark and Weston Cells.* **W. Marek.** (Ann. d. Physik, 1. 3. pp. 617–620, March, 1900.)—This is a set of tables of the E.M.F. of Clark cells at temperatures ranging from 0° to 30°, and of Weston cells between 0° and 10° calculated from the formulæ supplied by the researches of the Physikalisch-Technische Reichsanstalt. E. E. F.

1092. *Voltaic Cells with Compound Electrodes.* **F. S. Spiers.** (Elect. Rev. 45. pp. 911–912, Dec. 8, and p. 953, Dec. 15, 1899.)—If a cell has one plate of brass and the other of zinc with a plate of steel in contact with the latter beneath the electrolyte, the E.M.F. varies with the position of the zinc and steel plates relatively to the brass. For example, when the steel faces the brass the E.M.F. is 0·6 volt, but when the zinc faces the brass the E.M.F. is 0·9. The same effect is seen when a copper-plated iron rod, from which some of the copper is removed, is opposed to a copper plate. When only a very small piece of the iron is exposed the E.M.F. is the same whether the spot of iron is facing the copper plate or is turned away from it; but if a considerable length of the rod on one side is exposed, the E.M.F. differs in these two positions. The author attributes this phenomenon to the presence of local currents between the two parts of the compound electrode. The work done on a unit of electricity in moving it from one pole to the other depends upon the E.M.F. of the couple increased or diminished by drop of potential along the stream line of local current which is chosen as the path, and the E.M.F. therefore depends upon the relative positions of the plates. The explanation is confirmed by measurements of P.D. between the compound electrode and various points on a stream line. The author finally discusses the protective action of zinc in boilers. W. R. C.

1093. *Alternating Current Diagrams.* **R. A. Philip.** (Elect. World and Engineer, **34**. pp. 970–972, Dec. 23, 1899.)—The actual circuit is represented by a conventional diagram called the circuit diagram, which differs from the usual conventional picture of the circuit in that the latter shows the mechanical relations of the parts of the circuit to each other and to other related objects, while the former is concerned with the electrical connections only. The essential features of this diagram are that it shall show every junction-point and every branch.

Difference of potential has only two qualities, amplitude and phase, and these may be represented by a length and an angular direction respectively. In order that this representation may be definite in a given diagram, it is necessary to assume some length as a unit of potential measurement, and some direction as a basis of phase angle displacement. Absolute potential is the difference of potential between a given point and the zero point. Therefore, when any one point of a diagram is assumed to represent a given absolute potential, each other point will also represent a definite absolute potential.

In constructing a potential diagram for a circuit from the circuit diagram the above three assumptions may be made as follows: (1) Assume that the potential of some junction point A (fig. 1) is represented by a point A′ of the diagram, fig. 2. (2) Assume that the phase of the difference of potential in some branch *a* radiating from A is represented by the direction of a line *a*′ through A′. (3) Assume that the amplitude of the difference of potential in the branch *a* is equal to the length of the line *a*′. The potential of each junction point now corresponds to a definite point of the diagram, and it is only necessary to mark these points in order to represent the junction point potentials; these points may be styled junction points of the potential diagram.

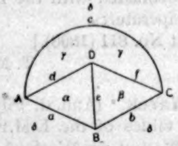


FIG. 1

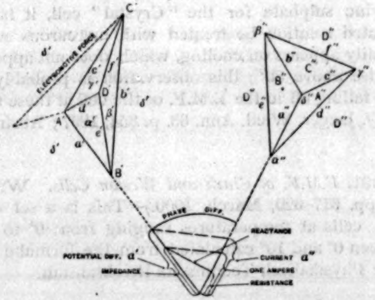


FIG. 2 FIG. 4. FIG. 3

Comparing the potential diagram with the circuit diagram: (1) Junction points correspond to junction points. (2) Connecting lines correspond to branches. (3) Meshes correspond to meshes.

In constructing a current diagram three assumptions may be made as follows: (1) Assume that some mesh (say *a*′ fig. 2) of the potential diagram corresponds to some point *a*′ of the current diagram, fig. 3. (2) Assume that the phase of the current in some branch bounding the mesh *a*′ (say *a*′) is represented by the direction of the line *a*″ through the point *a*″. (3) Assume that the current amplitude in the branch a' is equal to the length of the line a''.

Each mesh of the potential diagram now corresponds to a definite point of the current diagram, and it is now necessary to find these points. From the point a'' construct all the currents which bound the mesh a'. The point at the outer extremity of each of these current vectors represents the mesh of the potential diagram which the corresponding branch separates from the mesh a', and so on.

Comparing the current diagram with the potential diagram: (1) Junction points correspond to meshes. (2) Currents correspond to connecting lines. (3) Meshes correspond to junction points.

Fig. 4 shows the construction for the determination of the impedance and resistance of the circuits. W. G. R.

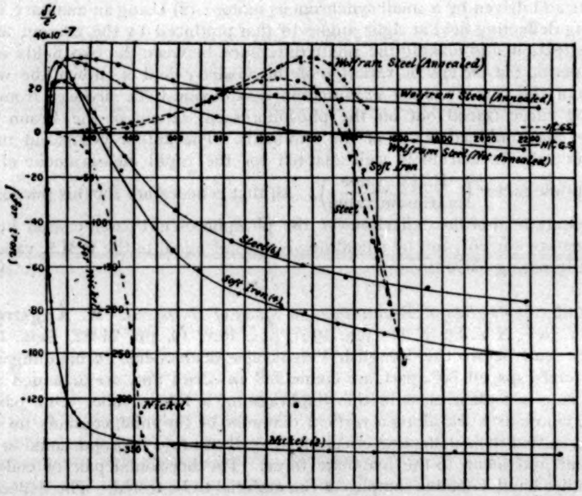
1094. *Optical Methods of Determining Wave-Forms.* **E. E. Seefehlner.** (Zeitschr. Elektrotechn., Wien, 18. pp. 5–8, Jan. 1; 23–25, Jan. 7; 44–46, Jan. 21; and 55–59, Jan. 28, 1900.)—This is an account of a large number of experiments carried out by the author with a Braun tube (see Phys. Soc., Abstract No. 277, 1897). Two methods were used for obtaining the wave-shape: (1) Photographing the wave on a cylinder covered with sensitised paper and driven by a small synchronous motor; (2) Using an auxiliary alternating deflecting field at right angles to that produced by the current under investigation, and making the phase difference between the two fields equal to ¼ period; if the law of variation of the auxiliary field is known, the wave-form of the current under examination may obviously be deduced from the closed curve traced out on the phosphorescent screen of the Braun tube under the combined action of the two fields. The author points out that a Braun tube is extremely well adapted for the rapid measurement of the amplitude factor $\left(\frac{\text{R.M.S. value}}{\text{maximum value}}\right)$. All that is necessary for this purpose is a measurement of the deflections of the phosphorescent patch caused by the alternating current, and by a continuous current equal to the R.M.S. value of the alternating current. A. H.

1095. *Application of Braun Tube to Study of Hysteresis.* **K. Ångström.** (Elect. Rev. N.Y. 36. p. 38, Jan. 10; Phys. Rev. 10. pp. 74–82, Feb., 1900. Paper read before the Konglish Vetenskaps-Akademiens Forhandlingar.)—Four coils, spaced 90° apart, are connected in series and are arranged with their axes in a plane close to the diaphragm of a Braun tube. One pair of coils, whose axes are along a vertical diameter of the tube, contains no iron cores, so that their deflecting effect on the kathode rays is proportional to the current, and hence to the magnetic force. The horizontal pair of coils, on the other hand, contains samples of the material to be tested. The deflecting effect of this second pair of coils is proportional to the magnetisation of their cores. If the two sets of coils are connected to a source of alternating E.M.F., a fluorescent hysteresis loop appears on the screen of the Braun tube. Specimens of loops obtained in this manner are given. The following modification is suggested by the author for comparing different samples. Each of the two horizontal coils contains a different sample (instead of identical ones as in obtaining the ordinary hysteresis loops), and the vertical coils are entirely removed. If the two samples are of precisely the same magnetic quality, a simple rectilinear vibration will result; but the slightest difference between them will be exhibited by a characteristic curve. A. H.

1096. *Molecular Magnetic Susceptibilities.* **S. Meyer.** (Deutsch. Phys. Gesell., Verh. 1. 15. pp. 275–277, 1899.)—The author clears up some questions of priority between himself and du Bois, Wills, and Liebknecht. [See Abstracts Nos. 1922 (1899), and 523 (1900).] He points out the remarkable general agreement between the values found by the former by a wet method, and by himself by a dry method, the series of atomic magnetisms found by the former for Pr : Nd : Sa : Ga : Er being in the ratio of 3 : 5 : 12 : 26 : 37, and as found by himself, 2 : 5 : 10 : 23 : 40. The paramagnetism of yttrium and ytterbium is probably due to traces of erbium, which has a remarkably high susceptibility. E. E. F.

1097. *Change in the Size of Iron, Steel, and Nickel by Magnetisation.* **H. Nagaoka** and **K. Honda.** (Phil. Mag. 49. pp. 329–343, April, 1900.)—Changes in length of iron, steel, and nickel ovoids produced by the action of the magnetic field are noted by means of the optical lever—changes of volume by placing the ovoids in a glass tube containing liquid, provided with a capillary neck.

The continuous lines in the figure below show the relation between the field and the proportional elongation (or contraction), whilst the dotted lines show the relation between the magnetic intensity and the elongation. It will be noted that initially iron and ordinary steel elongate when placed in a magnetic field, but that with increase of field contraction ultimately occurs. Like iron, annealed Wolfram steel shows a maximum elongation, but it indicates no signs of an ultimate resultant contraction. The paper also contains curves similar to those in the figure showing the relation between the increase in volume of the various ovoids, and the strength of the field; and the relation between the increase in volume and the intensity of magnetisation. Kirchhoff's equations show the relation between the changes in length and volume, and the values of Young's Modulus and the Modulus of



Rigidity; by means of these equations the effects of tension and torsion on the magnetisation of the ovoid can be tentatively calculated. Comparisons are made between the calculated and the actual effects. A. G.

1098. *Ship's Compass.* (Electrician, 44. p. 596, Feb. 16, 1900.)—In 1854 Scoresby suggested fixing the compass right aloft, so as to avoid errors due to iron in the ship. This idea is now carried out by Evoy in a compass which can be hauled up into the rigging. A carrying frame is provided with a system of cords and pulleys for maintaining the proper position, so that the compass swings clear. An automatic locking device is provided for the card. When hauled up, two hemispherical projections are engaged in corresponding cavities, thus fixing the frame and liberating the card. The card becomes locked at the instant that the compass begins to descend. Readings of the locked card are taken on deck. R. A.

1099. *Electric Tramways and Magnetic Observatories.* **v. Bezold.** (Elektrotechn. Ztschr. 21. pp. 161–164. Discussion, pp. 164–165, Feb. 22, 1900.)—Upon the basis of the researches of Eschenagen and Edler, at Potsdam and Spandau, the author pleads for the protection of magnetic observatories from disturbances due to earth returns of electric railways. He shows that terrestrial magnetism was the parent and precursor of electric telegraphy and of the whole of electro-technology, that it involves enormous commercial interests, and that it is in imminent danger of being made a science impossible to prosecute. For the purposes of modern navigation it is essential that magnetic charts should be republished every five years, and the revision cannot be successfully carried out without fixed points analogous to the fundamental points of a trigonometrical survey. In countries where, as in the United States, the boundaries of territories and states are fixed by the compass, endless legal difficulties are occasioned by slight errors in the magnetic variation. Earth returns have already ruined the work of the Washington, Toronto, Vienna, Nice, Copenhagen, and Batavia observatories; and others are threatened. It is practically impossible to secure sites away from possible disturbances, unless magneticians of high standing are to share the fate of lighthouse-keepers. Metallic returns appear to be the only efficient safeguard. E. E. F.

MEDICAL ELECTRICITY.

1100. *Voltaic Alternatives in the Treatment of Muscular Atrophies.* **C. Truchot.** (Archives d'Él. Médicale, 8. pp. 145–148, April, 1900. Paper read before the Association française, Boulogne.)—This monograph refers to an apparatus designed for the purpose of submitting a muscle to "voltaic alternatives." It consists of a reverser fixed upon a motor, the speed of the latter being regulated by means of a rheostat, and capable of attaining 40 revolutions a second. By means of this apparatus, instead of the simple muscular contraction produced at the opening or closure of a continuous current, a tetanisation of the muscle may be produced like that resulting from the application of a Faradic current. A further advantage of this arrangement is that the alternations do away with electrolytic action and the danger of scarring; and it is evident that the muscle, whether showing reaction of degeneration or not, will be excited by one or other of the changes. In support of the claims of his apparatus the author mentions the case of a boy suffering from infantile paralysis in which it was employed, using 4 or 5 milliamperes and about 30 reversals a second. Tetanisation was complete; rhythmical contractions being secured by means of a pendulum interrupter. At the end of fifteen séances of ten minutes daily Faradic contractility was re-established in the muscles, and a fortnight later cure was complete. W. S. H.

1101. *Low-Tension Alternating Current Accident.* **A. Kolben.** (Elektrotechn. Ztschr. 21. pp. 133–134, Feb. 15, 1900.)—While the lighting dynamo of some potash works near Prague was under repair, the glow lamps were connected between one phase and the neutral wire of the triphase power plant working at 190 volts, and were thus on an alternating 110-volt circuit. One man, standing on an iron soda tank, with his boots soaked with soda and his bare hands probably wet with lye, is supposed to have slipped and to have touched one of the naked wires of a lamp. A hot wire voltmeter quite close to the spot afterwards indicated 96 volts between the wire and earth. Two of the man's fingers stuck to the wire, and as his fellows taking hold of his free right arm received shocks, five minutes may have elapsed before he was released. All attempts to revive him failed, although they were commenced at once and a physician was promptly summoned. The post-mortem disclosed mechanical abrasion on the left hand and proved the man to have been a hard drinker, but left the direct cause of death doubtful. Alcoholism probably rendered him particularly sensitive to electric shocks.
H. B.

1102. *Treatment of Extensive Vascular Tumours by Electrolysis.* **J. Bergonié.** (Archives d'Él. Médicale, 8. pp. 106–115, March, 1900.)—These vascular tumours are classed according to their gravity or importance. In the first class are placed those which rise little or not at all above the surface of the skin. In the second are those formed by capillary vessels of new formation not differing from normal vessels, and showing neither dilatation nor sanguineous cavities. In the third class are placed "cavernous angiomata," in which there are cavities more or less like the cavernous tissue of erectile organs. The author takes for granted the universally recognised efficacy of electrolytic treatment of ordinary nævi. In the large cavernous variety, however, the prognosis is more grave, and the result less certain. Nevertheless it will prove very satisfactory to those who undertake it by the following method: The instrumentation consists of that always employed in every electrolytic operation, *i.e.*, a continuous current, a milliampere meter graduated from zero to 100 milliamperes, and a rheostat capable of varying very gradually the intensity of the current. With reference to the galvanic source, it is important not to work through too high a resistance, *i.e.*, to work with just such an amount of electromotive force as is necessary for the purpose in hand; 20 to 30 volts is quite sufficient. Two needles should be used, the bipolar method being the best. They will be as rigid as possible with a diameter from 0·5 to 0·8 of a millimetre, and usually about 3 centimetres long. With reference to the insulation of the needles, the following will be found a useful rule. Having decided what depth the needle is to be inserted in the tumour, half of that distance only must be left bare or uninsulated. In operating, choose the most salient points of the tumour to insert the needles. To be sure of a sufficient localisation of current, the needles should not be more than 12 to 15 mm. apart. The intensity of the current and duration of the operation will depend upon the case, but a proper result will seldom be obtained with less than 40

milliamperes, and a duration of at least 5 min. At each sitting at least 3 or 4 bipolar punctures ought to be made in a tumour of any size. Sometimes one sitting will be sufficient, but their number and frequency will depend upon the hardening of the electrolysed part, the cessation of pulsation in the tumour, and other evidences of the effect of the electrolysis.
W. S. H.

1103. *Electrolytic Treatment of Urethral Stricture.* **R. Newman.** (Archives d'Él. Médicale, 8. pp. 116–121. Discussion, pp. 121–123, March, 1900. Translated from the Journal of Electrotherapeut, New York, March, 1899.)—The author has successfully employed electrolysis in more than one thousand such cases during the course of thirty years. This treatment has proved successful beyond doubt. Many practitioners, not understanding the method, avoid it, because our medical colleges give little or no instruction in electrotherapeutics. The pathology of stricture is entered into, and it is pointed out that progressive dilatation is an ideal treatment in cases of slight pathological alterations in the mucous membrane; but it is not competent to deal with submucous infiltrations and fibrous formations more or less profoundly situated. It is then explained that in the electrolytic method, as in the case of the decomposition of any compound body by electricity, acids and oxygen form at the positive pole producing coagulation, thereby acting as an acid, and leaving a hard elastic cicatrix. At the negative pole there appear hydrogen and bases of salts; albumen is coagulated and absorption produced. This pole acts rather as a caustic alkali. It does not cause much pain during the application, and after the use of a very strong current a cicatrix remains which is soft and non-retractable. The very different results that follow electrolysis depend on the intensity of the current and the duration of the application. For surgical purposes the rule is as follows: Weak currents produce absorption, strong currents produce cauterisation and destruction of tissue. Therefore it follows that in the treatment of stricture weak currents ought to be employed—5 milliamperes or less—using the negative pole. What we aim at is chemical and galvanic absorption. The séances are short (5 to 20 min.) and repeated at a week's interval. If it is asked, what absorbs? and what is absorbed? the answer is that the galvanic current by the decomposition it brings about absorbs by degrees pathological formations which are encroaching on the calibre of the urethra. Several types of electrodes are employed, the most useful being one with a slight curve and an olive-shaped metallic tip. All the rest of the electrode is of course insulated. The region affected must in the first instance be thoroughly explored. The position of the patient is not a matter of much consequence, and anæsthetisation is not necessary as there is no pain. W. S. H.

1104. *Cinematoradiography of the Heart.* **H. Guilleminot.** (Archives d'Él. Médicale, 7. pp. 553–564, 1899.)—This paper describes an apparatus which enables the movements of the heart and arch of the aorta to be reproduced by means of Röntgen rays and the cinematograph. It is necessary to pass the Röntgen rays through the thorax at a given phase of the cardiac movement, and to repeat the operation a sufficient number of times. The latter necessity arises from the fact that radiography cannot like ordinary photography *instantaneously* take an image of any particular phase in a movement. The apparatus to effect these objects is briefly and technically described, and does not admit of abridgment. W. S. H.

1105. *Measurement of the Penetrating Power of Röntgen Rays by means of the Spintermeter.* **A. Béclère.** (Archives d'Él. Médicale, 8. pp. 153–157, April, 1900.)—The author is in the first instance careful to explain that the spark-measurer, or spintermeter (σπιντηρ, a spark), is in no way a new invention, nor even a new idea; it is only a rule or rod graduated in centimetres; but it will be found a useful addition to the radiographic outfit. It is well known that the penetrating power of Röntgen rays increases and decreases with the resistance of the tube—a resistance depending on the calibre of the tube, distance of electrodes, degree of vacuum, and qualities of the passing current. During the course of radiographic or radioscopic examinations, this resistance varies from one moment to another. It almost always increases, but sometimes it suddenly diminishes in consequence of the warming of the antikathode. These variations in resistance become evident through corresponding variations in the luminosity of the tube and distinctness of the shadows thrown upon the screen, but are only very imperfectly appreciated in this fashion; one of the reasons being that a personal element comes into play which is always undergoing change, that is to say, the sensibility of the retina alters; it may increase after remaining less than 20 minutes in the dark, in the proportion of 1 to 200. It is known that the best way of ascertaining the resistance of a tube is to ascertain what is known as the "equivalent spark." The spintermeter is only a detonator graduated to measure the length of the spark. It consists of a metallic rod divided into half centimetres, terminating in a point at one of its extremities, and an ebonite handle at the other. This rod moves easily in a metallic socket placed upon an insulating support, so that the point can be approximated or removed at will from another metallic point (fixed upon a second insulating stand) about 35 centimetres distant from the first. This is placed in circuit with the coil and tube. If there is a spark between the two fixed points the movable rod is withdrawn until there is no longer a spark at each discharge, and the scale marks the length of the spark and the corresponding resistance of the tube. If the resistance of the latter is not what is required, it can be increased or diminished by means of the Osmo-regulator of Villard,—an arrangement for introducing gas into the tube or removing it as desired. The spintermeter can be constructed so as to work either vertically or horizontally. W. S. H.

REFERENCES.

1106. *Dissymmetrical Currents in the Secondary of a Transformer, with a Wehnelt Interrupter in the Primary.* **O. M. Corbino.** (Accad. Lincei Atti, 8. pp. 359–365, 1899.)—Experimental details. Discussion as to the cause of the dissymmetry, whether due to the passage only of currents at make or to a phenomenon analogous to the electric arc. A. D.

1107. *Theory of Induction Coil.* **H. Armagnat.** (Écl. Électr. 22. pp. 121–125, Jan. 27, 1900.)—A theoretical discussion of the mode of action of an induction coil. Taking into account the condenser, induction, capacity, &c., the conclusion is once more deduced that mechanical interrupters should have as high a speed as possible at the moment of break. D. E. J.

1108. *Universal Galvanometer.* **O. Schöne.** (Zeitschr. Instrumentenk., Beib. 2 pp. 13–15, Jan. 15, 1900.)—This galvanometer contains a combination of resistances, binding screws and keys, which by different groupings enable E.M.F.'s, resistances, insulation resistances, and current strengths to be measured. It is in fact a complete testing-set, Siemens and Halske being the makers. J. B. H.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1109. *Argon and its Combinations.* **Berthelot.** (Annal. Chim. Phys. 19. pp. 66–89, Jan. 1900.)—From 690 cc. of crude argon, after freeing from nitrogen by sparking with oxygen over potash, or with glycolic ether (one of the best absorbents of nitrogen) there resulted 455 cc. of the pure gas. From 5 to 10 cc. was confined over mercury in a tube enveloped in a large platinum or aluminium spiral. An inverted syphon filled with 10 per cent. sulphuric acid had its inner closed end pushed up into the gas tube. The spiral and syphon being made the two poles of an induction coil, the current traversed the two thicknesses of glass and the annular space of gas, avoiding strong sparks as in an ozoniser. About 0·1 or 0·2 cc. of the liquids under trial was introduced, the very slight solubility of the gas being neglected. The results varied with tension, temperature, and other circumstances. Ethene, glycolic ether, aldehyde, acetone, and compounds of the fatty series generally, while suffering some decomposition, showed no absorption of argon, and no luminosity in 20–24 hours. With the benzene group combination occurred easily, with a varying green luminosity showing the lines of A, Hg, C, and H, and an absorption from 1 per cent. (aniline) to 8 per cent. or more (benzene). Ring compounds of the C_4 and C_5 groups gave intermediate results. Further experiments were made with benzene in regard to its polymerisation and the formation of *phenylmercurargon*, also with carbon disulphide: 34 of the latter fix 2 of argon, forming a yellowish amorphous, solid, from which heat regenerates a small quantity of argon. From the liberation of argon from some minerals the author argues the existence of *argonides* of the metals.

S. R.

1110. *Melting-Point of Chloral Hydrate.* **C. G. L. Wolf.** (Journ. Phys. Chem. 4. pp. 21–32, Jan., 1900.)—The author describes a number of experiments on the melting of chloral hydrate, and concludes that the differences observed in the melting-point are due to dissociation phenomena and not to the presence of two different modifications in the melted mass. The two forms described by Pope—namely, the long uniaxial needles obtained on cooling fused chloral hydrate under a microscope cover slip and the monosymmetric plates deposited from a solution in chloroform—show identical behaviour on heating. The melting-point of the undissociated substance is above 72°, at which temperature the sublimation pressure is about 22 mm. The triple point for chloral hydrate and its dissociation products is about 47°.

T. H. P.

1111. *Solubility of Carbonic Acid.* **C. Bohr.** (Ann. d. Physik, 1. 2. pp. 244–256, Feb., 1900.)—The solubility of carbonic acid in alcohol was determined between the temperatures of 45° and $-12°$ by precipitating the acid from the solution with baryta water, and between $-12°$ and $-67°$ by an absorptiometric method. The formula $a(T-n) = K$ can be used as an interpolation formula for all temperatures, except the portion below $-27°$ where the fall of n is too great. The following are some of the absorptions found:—

Temperature	−65	−25	−10	0	10	20	30	40
Absorption	38·41	8·75	5·75	4·44	3·57	2·98	2·57	2·20

The coefficient of evasion, *i.e.*, the amount of carbonic acid penetrating 1 sq. cm. of the surface per minute was found to be 0·574 at standard temperature and pressure. The coefficient of invasion was similarly found to be 2·375.

E. E. F.

1112. *Heat of Combination of Copper with Zinc.* **T. J. Baker.** (Chem. Soc., Proc. 15. pp. 195–196, 1899.)—The author measures the difference between the heat of solution of the alloy and the sum of the heats of solution of the pure metals in the same proportions. The solvents used were chlorine-water (0·15 normal) and nitric acid (HNO_3, $3H_2O$). From 0 to 30 per cent. of copper, no heat of combination could be detected. From 30–62 per cent. of copper, the curve (*i.e.*, the heat of formation of 1 grm. alloy plotted against percentage of copper) rises to an ill-defined maximum. From 62–100 per cent. of copper the curve gradually sinks to zero. F. G. D.

1113. *Reversible Photochemical Processes.* **R. Luther.** (Zeitschr. Phys. Chem. 30. pp. 628–680, Dec. 30, 1899.)—Those chemical actions in which light affects not merely an increase in the velocity of a chemical reaction which is capable of proceeding spontaneously, but causes an actual disturbance of the chemical equilibrium involving an expenditure of energy, can be employed as a means of determining the relations prevailing during the transformation of radiant into chemical energy. In the reversible photochemical process examined by the author—that of the darkening of silver chloride or bromide—when the equilibrium existing between the free halogen and the dark reduction product of the silver haloid is disturbed, the change in the intensity of the chemical energy can only be compensated by an equivalent but opposite change of the light intensity.

In order to examine the relation existing between the intensity of light and the equilibrium pressure of the halogen, glass plates on the surfaces of which the silver haloid has been slowly deposited, are illuminated on the back surface by light passing through a tube photometer containing 16 tubes, the front side being in contact with solutions of the free halogen; the extent of the light action is shown by the number (N) of black spots produced on the plate. The curves connecting the logarithm of the concentration (C) with N, both for silver chloride and bromide, are not rectilinear but are convex towards the axis of N. To test the theoretical relation $A = aI + b$ (A being the affinity of the reaction, I the intensity of the light, proportional to N, and a and b constants), the affinity A is measured by determining the E.M.F. of a halogen concentration cell; between the limits of concentration used above, it is found that the E.M.F., and consequently A, is proportional to log C. Hence it follows that A is not proportional to I, and the relation $A = aI + b$ does not hold. This discord between theory and experiment the author concludes is due to either inaccuracy or incompleteness of the theory or to some constant experimental error. Attempts were made, without success, to obtain light phenomena from the bleaching by chlorination or bromination, in the dark, of the blackened silver haloid.

To bleach either the latent or visible image (in absence of an organic medium), the oxidation-potential just sufficient is, in the case of silver chloride, 1·44, and for the bromide 1·14 volts; the latent and visible images have hence very probably the same composition. To investigate the chemical nature of the blackened product, the oxidation potentials of a halogen solution are determined after it has been shaken up with increasing quantities of powdered silver. It is found that the potential remains unchanged until almost exactly one-half as much silver has been added as is required by the formula AgCl or AgBr ; at this point the potential suddenly rises to 1·44 volts in the case of the chloride, and to 1·14 in the case of bromide of silver, these values remaining constant until the amount of silver added is equivalent to the halogen present. This behaviour points, with a very high degree of probability, to the existence of the compounds Ag_2Cl and Ag_2Br, and also shows that other silver sub-haloids, such as Ag_4Cl_3 for example, do not exist ; it also indicates that the darkened product of the action of light on the silver haloids, in absence of organic matter, has the composition Ag_2Cl (or Ag_2Br).

The author works out a theory of reversible photochemical processes from the laws of radiation and of energy ; this he only advances as a working hypothesis, which is as yet by no means confirmed by experimental data.

T. H. P.

1114. *New Sulphate of Magnesium and Potassium.* **J. H. van't Hoff** and **N. Kassatkin.** (Preuss. Akad. Wiss. Berlin, S. ber. 51. and 52. pp. 951–953, 1899.)—This is another of the series of papers on the Stassfurt salt deposits. [See Abstracts, Nos. 1939 (1899) and 226 (1900).] While experimenting on the double sulphates of magnesium and potassium the authors have discovered a hitherto unknown salt having the formula—

$Mg_4K_2(SO_4)_5 . 5H_2O$, which stands in the same relationship
to $4(MgSO_4) . 5H_2O$ as Schönite, $MgK_2(SO_4)_2 . 6H_2O$, stands
to $MgSO_4 . 6H_2O$, and as Leonite, $MgK_2(SO_4)_2 . 4H_2O$, stands
to $MgSO_4 . 4H_2O$.

This new salt is formed by heating a mixture of $MgSO_4 . 6H_2O$ and Leonite to 72·5°, at which temperature a considerable expansion takes place, a corresponding contraction following immediately on cooling. It may also be formed by heating to about 80° a mixture of finely powdered potassium and magnesium sulphates in the proportions of 1 molecule to 4 molecules, the heating being done under oil to prevent drying. The long needle crystals removed from the mother liquor at about 80° and dried gave on analysis a formula in close agreement with the above.

J. B. H.

1115. *Cryoscopic Observations.* **K. Auwers** (with **F. H. Betteridge, W. Bartsch, M. Dohrn,** and **H. M. Smith.**). (Zeitschr. Phys. Chem. 32. pp. 39–62, Feb. 6, 1900.)

1. *Hydroxyketones in Naphthalene.* With the exception of *p*- nitrobenzoyl-*p*- cresol which shows an abnormally *low* molecular weight decreasing as the concentration increases, all the orthohydroxyketones examined behave normally, in accordance with the laws already stated. (See 1900, Abstract No. 544.) The parahydroxyketones show the usual abnormal behaviour of phenols.

2. *Substituted Phenols in Naphthalene.* The abnormal behaviour of methyl *p*-hydroxybenzoate is very largely reduced by a halogen atom in the ortho-position to the hydroxyl group, the influence of the three halogens being almost identical. Para- and meta-hydroxybenzaldehyde are strongly abnormal, but their substitution products only in a much less degree. Of the divalent phenols, pyrocatechol and resorcinol are both abnormal, but the monomethyl ether of pyrocatechol is quite normal.

3. *Nitroso-compounds in Naphthalene.* Nitrosobenzene behaves quite normally, but derivatives of *p*- nitrosoaniline show an abnormal behaviour which is perhaps an indication that they have a quinonoid structure.

4. *Dimethyl Oxalate as a Solvent.* Phenols and acid-amides give abnormal

cryoscopic values when dissolved in dimethyl oxalate, but the deviations are only small, especially in the case of phenols. The depression constant is 50.

5. *p- Azoxyanisole as a Solvent.* This substance melts at 117° to "liquid crystals," which disappear at 134·5°, when the liquid becomes isotropic; cryoscopic determinations can be carried out at the transition-point from liquid crystal to true liquid, and the depression-constant was found by Schenck to have the extraordinary value $K = 764$. This value is probably too high, and a redetermination has given $K = 545$ as a mean value for five substances. Using this value normal results were obtained even with substances which behave abnormally in other solvents. T. M. L.

1116. *Stassfurt Salt Deposits and Saturated Solutions of Chlorides.* **H. A. Wilson.** (Preuss. Akad. Wiss. Berlin, S.ber. 51. and 52. pp. 954–955, 1899.)—Suppose the saturated solution of chlorides to be as follows :—

$$1{,}000H_2O\ a\ Cl_2Na_2\ b\ Cl_2K_2\ c\ Cl_2Mg\ d\ SO_4Mg,$$

then the author concludes that—

$$b + \frac{c}{5} = \text{const.}$$

The following table gives the experimental proof :—

	K_2Cl_2	$MgCl_2$	$K_2Cl_2 + \frac{MgCl_2}{5}$
NaCl and KCl	19·5	0	19·5
NaCl, KCl and Glaserite	20	0	20
„ „ and Carnallite	5·5	70·5	19·6
„ „ Glaserite and Schönite	16	18·5	19·7
„ „ Schönite and Leonite	14·5	25·5	19·6
„ „ Leonite and $MgSO_4 . 6H_2O$	13	30·5	19·1
„ „ $MgSO_4 . 6H_2O$ and $MgSO_4 . 5H_2O$	6·5	63	19·1
„ „ $MgSO_4 . 5H_2O$ and Carnallite	6	68	19·6
„ „ and $MgSO_4 . 6H_2O$	7·8	55·8	19
„ „ Schönite and $MgSO_4 . 6H_2O$	9·5	42·5	(18)
„ „ in 20 per cent. $MgCl_2$	9·5	47·5	19

J. B. H.

1117. *Molecular Weight of Sulphur by the Ebullioscopic Method.* **L. Aronstein** and **S. H. Meihuizen.** (Archives Néerlandaises, 3. pp. 89–130, 1899.)—In view of the discrepancies between existing determinations of the molecular weight of sulphur in solution, the authors have carried out a large number of experiments by the ebullioscopic method, using as solvents carbon bisulphide, benzene, toluene, xylene, naphthalene, phenol, and sulphur chloride, having boiling-points ranging from 46° to 214°. Some modifications in the apparatus employed are described, and the experimental results are recorded in the form of tables and curves. The following general conclusions are arrived at : There is no distinct difference between the molecular weights of sulphur determined at temperatures below and above the point of transformation of the rhombic into the triclinic modification, and this remark also applies to determinations above and below the melting-point. Thus, measurements with toluene at 110° point to the existence of the molecule S_7, whilst those with xylene at 139° give results intermediate between S_7 and S_8. In carbon bisulphide sulphur has a molecular weight in accord with the formula S_8 and not S_9 as stated by Orndorff and Terrasse. With regard to the use of sulphur chloride by these observers, who obtained therewith the value S_3, it is shown that this liquid is partially dissociated at its boiling-point into chlorine and sulphur. It is therefore ill adapted for molecular weight determinations and the results obtained with it are untrustworthy.

N. L.

1118. *Catalytic Action of Neutral Salts.* **H. Euler.** (Zeitschr. Phys. Chem. 32. pp. 348–359, Feb. 20, 1900; from the Öfversigt af K. Svenska Vetenskaps Akademiens Forhandlingar, 5, 1899.)—Neutral salts have the greatest effect in accelerating the inversion of cane sugar by acids when the concentration of the acid is small; the effect is slightly less at higher temperatures, and is slightly greater when the concentration of the sugar is large. The influence of neutral salts in the hydrolysis of esters by acids is similar in magnitude and in character, but in the saponification of esters by alkalies neutral salts often have a retarding, and not an accelerating effect. It is suggested that the action of neutral salts may perhaps consist in increasing the degree of dissociation of the water in which they are dissolved.

T. M. L.

1119. *Calculation of Ionisation of Complex Solutions of given Concentration, and the Converse Problem.* **J. G. MacGregor.** (Nova Scotian Inst., Trans. 10. pp. 67–78, 1898–1899.)—The author describes a modified form of his graphical method for determining the degrees of ionisation in solutions containing two electrolytes possessing a common ion.

Denoting the electrolytes by 1 and 2, the concentrations (in grm.-equivalents per litre) by N_1 and N_2, the degrees of ionisation by a_1 and a_2, and the dilutions (in litres per grm.-equivalent) of the component isohydric solutions by V_1 and V_2, we have the equations :—

$$\frac{a_1}{V_1} = \frac{a_2}{V_2} \qquad (1)$$

$$N_1 V_1 + N_2 V_2 = 1 \qquad (2)$$

$$\frac{a_1}{V_1} = f_1(V_1) \qquad (3)$$

$$\frac{a_2}{V_2} = f_2(V_2) \qquad (4)$$

If we are given N_1 and N_2 and wish to obtain a_1 and a_2 there are various graphical methods whereby the desired result may be obtained. For example, as follows: Plot the curves (3) and (4) using ionic concentrations as abscissæ and dilutions as ordinates. Then plot a new curve such that its ordinate is equal to N_1 times, the corresponding ordinate of (3) plus N_2 times the corresponding ordinate of (4). By "corresponding" is meant "having the same abscissa." Draw the straight line $V = 1$. Through the point where it cuts the last-mentioned curve draw a vertical straight line. This line cuts (3) and (4) in two points. The corresponding ordinates are the values of V_1 and V_2, and the common abscissa the value $\frac{a_1}{V_1} = \frac{a_2}{V_2}$. The problem is therefore solved. Other very similar methods of effecting a graphical solution are discussed by the author.

To solve the converse problem the author points out that it is necessary to have some other datum besides the degree of dissociation. He then describes how to effect the solution graphically according as the other datum is (1) concentration of *one* electrolyte, (2) ratio of the concentrations with respect to the two electrolytes, (3) total concentration or difference of the two concentrations, (4) a given value for the conductivity of the solution.

Finally the author discusses the methods employed by Schrader (Zur Elektrolyse von Gemischen, Berlin, 1897), and by Kay (Proc. R. S. Edin. **22.** 502, 1898–99), for calculating ionisation-coefficients and contrasts them with his own method. F. G. D.

1120. *Relation of Viscosity of Mixed Solutions of Salts to their Ionisation.* **J. Barnes.** (Nova Scotian Inst., Trans. **10.** pp. 113–128, 1899–1900.)—This investigation is an application of MacGregor's method. The author first calculates from known data the molecular conductivities at infinite dilution for 25° C. in the case of aqueous solutions of KCl, NaCl, $BaCl_2$, Na_2SO_4, K_2SO_4, and $CuSO_4$, and hence the ionisation-coefficients for various dilutions at that temperature. Using the equation $P = P_w + k(1 - a)n + lan$, where $P =$ viscosity of solution, $P_w =$ viscosity of water, $n =$ concentration in grm.-equivalents per litre, $a =$ degree of dissociation, k and $l =$ two constants; the values of k and l are calculated by means of the viscosity measurements of Reyher and Wagner and the ionisation coefficients already obtained.

For mixtures obtained by the mixing of equal volumes of equivalent solutions, the general equation for dilute complex solutions:—

$$P = P_w + \frac{1}{p}\left\{ [k_1(1 - a_1)n_1 + l_1 a_1 n_1]\frac{v_1}{v_1 + v_2} + [k_2(1 - a_2)n_2 + l_2 a_2 n_2]\frac{v_2}{v_1 + v_2} \right\},$$

where $p =$ ratio of volume of mixture to sum of volumes of constituent solutions, $v_1, v_2 =$ volumes of constituent solutions, reduces in this case to $P = P_w + \frac{n}{2}\left\{ k_1(1 - a_1) + l_1 a_1 + k_2(1 - a_2) + l_2 a_2 \right\}$, since $p = 1$. The k's and l's in this equation have the values calculated for the simple solutions. Hence P, the viscosity of the complex solution may be calculated if a_1 and a_2 can be obtained. The values of a_1 and a_2 are calculated by using a slightly modified form of MacGregor's graphical method, as follows: If one employs specific conductivity and concentration instead of ionic concentration and dilution respectively, the equations given by MacGregor (see preceding Abstract) may be written in this form:—

$$k_1 = \frac{\mu_{\infty 1}}{\mu_{\infty 2}} k_2$$

$$\frac{N_1}{C_1} + \frac{N_2}{C_2} = 1 \quad \ldots\ldots\ldots\ldots\ldots\ldots (a)$$

$$k_1 = f_1(C_1) \quad \ldots\ldots\ldots\ldots\ldots\ldots (b)$$

$$k_2 = f_2(C_2) \quad \ldots\ldots\ldots\ldots\ldots\ldots (c)$$

This system is solved graphically as follows: Plot the curve (*b*), using specific conductivities as abscissæ and concentrations as ordinates. Plot (*c*) in a similar manner on the same paper, but give the curve a "parallel" displacement by multiplying the value of each specific conductivity by the factor $\frac{\mu_{\infty 1}}{\mu_{\infty 2}}$. Find by inspection two points, one on each curve, having a common abscissa and ordinates which satisfy equation (*a*). In this way, C_1, C_2, k_1 and k_2 are obtained, and hence a_1 and a_2 from the equations $\frac{a_1}{V_1} = \frac{k_1}{\mu_{\infty 1}}$, $\frac{a_2}{V_2} = \frac{k_2}{\mu_{\infty 2}}$. The values so calculated for the viscosities of solutions containing two salts with a common ion are compared with the experimental results of Kanitz. The agreement between the two appears to be tolerably good. F. G. D.

1121. *Chemical Equilibrium in a System containing Four Gases.* **H. Pélabon.** (Comptes Rendus, 130. pp. 576–579, Feb. 26, 1900.)—If mercury selenide is heated above 500° in an atmosphere of hydrogen it is partially reduced in accordance with the reversible equation—

$$HgSe + H_2 \rightleftarrows H_2Se + Hg.$$

If the partial pressures of these substances be p_1, p_2, p_3, and p_4 respectively, then $\frac{p_1 p_2}{p_3 p_4} = f(T)$. In presence of an excess of solid mercury selenide p_1 becomes a constant for each temperature, whilst if no excess of mercury is present $p_3 = p_4$, and the equation becomes $\frac{p_2}{p_3^2} = f(T)$; this equation has been verified for three pressures of hydrogen at 540°. In presence of an excess of mercury p_4 becomes a function of the temperature, and the equation is $\frac{p_2}{p_3} = f(T)$; the reduction of the selenide is largely prevented by the excess of mercury —a result which has been verified by experiment. T. M. L.

1122. *Equilibria with Two Liquid Phases in Systems composed of Water, Alcohol, and an Alkaline Salt.* **B. R. de Bruyn.** (Zeitschr. Phys. Chem. 32. pp. 63–115, Feb. 6, 1900.) — The following systems were studied: (I.) Ammonium Sulphate, Ethyl alcohol, Water. (II.) Potassium Carbonate, Methyl alcohol, Water. (III.) Potassium Carbonate, Ethyl alcohol, Water. (IV.) Sodium Sulphate, Ethyl alcohol, Water.

The contents of the paper may be summarised as follows :—

1. *Quadruple Curves investigated.*

System I.—Two liquid phases, solid $(NH_4)_2SO_4$. Below 8° two stable phases cease to coexist.

System II.—Two liquid phases, solid salt hydrate. The two liquid layers become identical at −35°.

System III.—Two liquid phases, solid salt hydrate. A critical solution-temperature was not observed.

System IV.—One liquid phase, $Na_2SO_4 . 10H_2O$, Na_2SO_4. Investigated from 32·5° to 10°.

2. *Triple Curves investigated.*

System I.—(*a*) One liquid phase, solid $(NH_4)_2SO_4$.

(*b*) Two conjugate liquid phases. Separation of a homogeneous solution produced by cooling or heating, according as the alcohol concentration is high or low. Mixtures of intermediate concentration become homogeneous on heating, but separate again on further rise of temperature.

System II.—Two conjugate liquid phases. On warming, an initially homogeneous mixture separates into two layers.

System III.—Two conjugate liquid phases. Mixtures of high or low alcoholic concentration behave as in I. (*b*). Intermediate mixtures on rise of temperature become at first homogeneous, then separate, and finally become homogeneous again.

System IV.—(*a*) One liquid phase and solid $Na_2SO_4 10H_2O$, Na_2SO_4, or $Na_2SO_4 7H_2O$. The last combination is supersaturated with respect to the decahydrate.

(*b*) Two conjugate liquid phases. This combination is always unstable, being at lower temperatures supersaturated with respect to decahydrate and at higher temperatures with respect to anhydrous salt. A homogeneous solution separates into two layers on cooling.

8. The author proves the existence of the hydrates :—

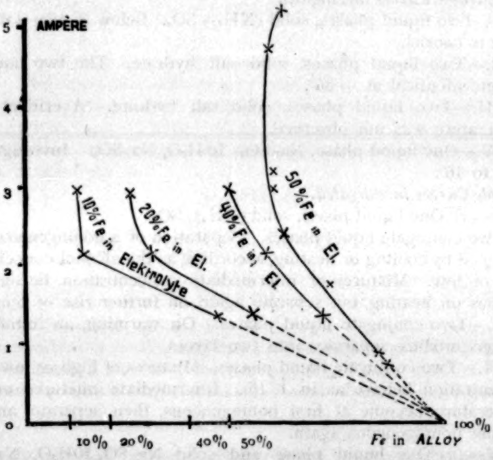
$$K_2CO_3 . 1\tfrac{1}{2}H_2O$$
$$K_2CO_3 . 2H_2O$$

and confirms the known fact that no stable hydrate of the formula $Na_2SO_4 . H_2O$ exists.

The paper contains a very great mass of data, and very complete bibliographical references. F. G. D.

1123. *Electro-deposition of Copper from Alkaline Solutions.* **S. Cowper-Coles.** (Elect. Rev. 46. pp. 255–256, Feb. 16, 1900.)—A description with figures of a plant erected at the works of the *Société des Mines et Fonderies de Zinc de la Vielle-Montagne* in Belgium for electro-depositing copper upon zinc sheets. Anodes of rolled copper are used, with an electrolyte containing the double cyanide of copper and potassium. This solution is made up to a strength of 1·12 sp. gr. at 15° C., and is worked at a temperature of 150° F. A current density of 10 amperes per square foot, and an E.M.F. of 1·6 volts are employed. The electrolyte is maintained at its proper strength by circulating through a filter containing finely divided copper. J. B. C. K.

1124. *Electro-deposition of Alloys.* **H. W. Toepffer.** (Zeitschr. Elektrochem. 6. pp. 342–344, 1899.)—Mixed solutions of the simple sulphates, of the double ammonium sulphates, and of the oxalates were used as electrolytes in the author's experiments, and the following alloys were deposited : Iron-nickel, iron cobalt, iron zinc, and cobalt-nickel. An attempt was made to obtain in a similar manner an alloy of iron and copper, but this failed.



The results obtained did not accord with the theoretical assumption that as the E.M.F. increased gradually from zero, the salt with the higher decomposing value would, from a certain point onwards, join to an increasing extent in the transfer of the current across the cell. As the E.M.F. and current increased, the metal requiring the higher E.M.F. to bring about its deposition was found to be deposited in a *diminishing percentage* at the kathode.

As an illustration of this phenomenon, the author gives the results obtained with an electrolyte containing ferrous and nickel sulphates, in the form of a diagram, and this is reproduced above. As the current and E.M.F. increase less iron is deposited, although ferrous sulphate has a higher decomposing value than nickel sulphate. The dotted portions of the curves are projections, and serve to indicate that as the current and E.M.F. approach zero, the alloy will contain chiefly iron and little or no nickel.

Details of the experiments with the other metals named above are given. In explanation of the anomalous results obtained, the author puts forward the suggestion that the noble metals—of which nickel is one—very readily form complex anions, and that possibly the salts of these noble metals do not dissociate very readily on solution in water. The amount of salt in solution in this case would therefore be no guide to the number of ions ready to take part in electrolytic work. J. B. C. K.

1125. *Electrolytic Hypochlorites.* **A. Sieverts.** (Zeitschr. Elektrochem. 6. pp. 364–370, Jan. 4; and 374–378, Jan. 11, 1900.)—The author summarises the results of recent work upon the best conditions for electrolytic hypochlorite production as follows :—

(1) The maximum concentration obtainable by electrolysis is between 0·5 and 0·6 grm. oxygen as hypochlorite per 100 cc. Beyond this point chlorate is alone produced (Haber and Grinberg. Müller). (2) A high current density is favourable for hypochlorite production (Oettel). (3) A high temperature is unfavourable for hypochlorite production (Oettel). (4) The concentration of the original salt solution used does not affect the result, provided that the electrolyte contains from 58–116 grms. of common salt per litre, or an equivalent amount of the other salts.

All of these conditions harmonise with the theory of hypochlorite formation in the electrolytic cell, recently advanced by Foerster ; but the second is in direct conflict with results obtained by Schoop, and the author, at Foerster's instigation, has undertaken the investigation of this point again. A description and sketch of the apparatus used is given. Platinum was used as anode material and iron as kathode. The methods of analysis used for determining the oxygen present as hypochlorite and as chlorate in the electrolysed solutions are described. Solutions of potassium chloride and of calcium chloride were used as electrolytes. The results obtained are reduced to a common form, and given in two tables. In each case the yield of hypochlorite increased with the current density, thus confirming the correctness of Oettel's results. In the course of the investigation it was found that the low current efficiency of the hypochlorite cell is due chiefly to reduction of previously formed hypochlorite by hydrogen at the kathode, and that under correct conditions of work, only a very small portion of the loss is due to the formation of chlorate, or to escape of gaseous chlorine at the anode. The author states that in all comparative investigations of this kind, it is imperative that equal current and equal flow of electrolyte should be maintained through the cell during the electrolyses. The time limit of the experiments is of no importance and should be neglected.

The second portion of the author's paper relates to the question of the high bleaching value of solutions of hypochlorite prepared by electrolysis. Foerster and Bischoff have ascribed this high value to the presence of free hypochlorous acid in the electrolysed solution. The direct proof of this was, however, impossible by chemical means until recently, when a new method of analysis worked out by Jorre was shown to yield reliable results if applied to solutions containing hypochlorous acid in presence of its salts. Solutions of potassium chloride, sodium chloride, and calcium chloride were used for preparing the bleaching solutions. The apparatus resembled that used in the first set of investigations. With the first two salts the yield of hypochlorite was small, and the chief loss was traced to kathodic reduction. The yield with calcium chloride was, however, much higher, and confirmed the results obtained by Oettel and others.

Applying the new method of analysis to these electrolysed solutions, it was found that the theory of Foerster and Bischoff was correct, and that all contained a large portion of their available oxygen in the form of free hypochlorous acid. In the case of the calcium chloride solution, the proportion was highest and amounted to 50 per cent. This solution was found to be less stable than the other two solutions when exposed to the air. In many cases free chlorine is present in the solutions, and this must be removed before Jorre's test for free hypochlorous acid can be applied. A special experiment made with a solution containing 8 grms. of sodium chloride and magnesium chloride = 2 grms. of sodium chloride, was found to yield 95 per cent. of the available oxygen as free hypochlorous acid. This solution proved, in accordance with the theory, a *most energetic* bleaching agent.

Attempts were made to carry out similar experiments with solutions containing magnesium chloride alone, but it was found impossible to remove the free chlorine from the solution after electrolysis, by aeration, and the application of Jorre's method for determining the amount of free hypochlorous acid present was therefore impossible. J. B. C. K.

1126. *Electrolytic Preparation of Indulin Dyes.* **E. C. Szarvasy.** (Zeitschr. Elektrochem. 6. pp. 403–407, Feb. 1, 1900.)—The electrolysis of fused aniline hydrochloride results in the formation of azophenin and colouring matters of the indulin class. The best results are obtained at 160°, using an anode current density of about 0·8 ampere per square decimetre. Mainly of chemical interest. N. L.

1127. *Ozone Generator.* (Elekt. Runds. 17. pp. 89–90, Feb. 1, 1900.)—Otto's apparatus for producing chemical effects by means of high-tension discharges do not contain any dielectric but air, and one or both electrodes or some other parts are movable. Within a cylindrical casting provided with inward projections, a disc, fitted with points, turns about a vertical axis. The air enters on one side through a distributing sieve and leaves on the opposite side. When the inner electrode is turned, discharges take place as the points approach the projections. For alternating currents at 50,000 volts the points are replaced by a cast screw, varnished or covered with a non-oxidisable metal. Both electrodes may also be stationary and separated by a revolving cylindrical screen, out of which sectors are cut. If the distance is normally too large for any discharge to pass, the screen is made of a conductor; if the electrodes are near one another, the screen consists of insulating material. H. B.

1128. *Stassano Process for the Electro-metallurgical Production of Iron.* **F. P. Mann.** (Scientific American, 82. p. 68, Feb. 3, 1900.)—This process for the production of iron and steel has been tested on a practical scale at

Rome, with favourable results. The furnace worked with Camonica ore, and utilised 100 H.P. In form the furnace resembles the ordinary blast furnace, the carbons for supply of the electric current being inserted horizontally, just above the hearth. The ores to be used are roasted, ground, and mixed with charcoal and pitch, before being placed in the furnace. Oxides of manganese, nickel, or chromium may be added during the grinding and mixing operations, in order to produce an iron or steel containing small amounts of these metals. It is estimated that one ton of metal can be produced in the Stassano furnace by the expenditure of 3,000 I.H.P. hours. Details of the thermal calculations upon which this estimate is based are given by the author. Three thousand H.P. hours can be generated in Italy at a cost of only 18 lire, and the whole process of iron production in the Stassano furnace can be carried out at a cost of 100 lire per ton, as compared with 160 lire by the ordinary blast furnace process.

A company has been formed to build a large works for operation of the process in the valley of Camonica; and three furnaces, each of 500 H.P. capacity, are to be forthwith erected at this place. It is expected that an output of 4,000 tons of iron and steel per annum will be attained when the works are completed. Two diagrams of the furnace accompany this description of the process. J. B. C. K.

1129. *Electric Furnaces, with Special Reference to the Production of Calcium Carbide.* **B. Carlson.** (Zeitschr. Elektrochem. 6. pp. 418–419, Feb. 8, and 429–434, Feb. 15, 1900.)—This is in the main a comparison between arc-furnaces and resistance-furnaces (in which heat is generated by the interposition of a fluid resistance, *e.g.*, the melted calcium carbide itself); and between continuous and intermittent-running of the furnaces. The resistance furnace cannot well be worked intermittently; but has the advantage that it consumes less electrode carbon and may therefore be run longer without intermission. On the other hand, the resistance varies greatly, and the current and, therefore, the temperature, are less under control; the lime and carbon mixture floats on the fluid carbide, and is thus not so well placed as in the arc-furnace where it is exposed to the full heat of the arc; whilst continuous currents must not be used, as they tend to cause electrolysis and hence volatilisation of calcium. *Continuous* furnaces have the disadvantage that the molten carbide comes in contact with the furnace-lining, which must therefore be more refractory in character (and must not, as in intermittent furnaces, consist of chamotte). Again, in consequence of the slag-like (viscous) character of the fluid carbide, and of its low specific heat, the temperature must be raised far above that at which the carbide flows freely (3,500°–4,000° C.) in order that it may be tapped, whilst in intermittent furnaces a temperature of 2,800°–3,000° C. suffices for the work; the proportion of dissociation in the continuous furnace is thus greater, calcium distils off, and the yield of carbide is lower, whilst a greater heat-expenditure is necessary. In practice the fusing-point is lowered by the addition of lime, but this gives a less pure carbide. The slow cooling of the charge in the *intermittent* furnace is economical because the reaction between lime and carbon continues markedly even at a temperature of 1,200°–1,500° C., and is therefore carried on economically during the cooling (by the waste-heat of the carbide already formed) in a portion of the charge not already treated; moreover, free calcium, which often exists dissolved in the carbide (even up to 10 per cent.), combines with free carbon during slow-cooling, but is practically prevented from so doing, owing to chilling, if the charge is tapped.

The loss of heat by radiation and convection also is necessarily greater in the hotter (continuous) furnace than in the other. Calculation in the case of a furnace covered with iron plates having a superficial area of 7·5 sq. m. showed (according to Peclet's formula) that in an intermittent furnace of which the outside was at a temperature of 100° C., the loss from these causes amounted to 8,197 calories per hour, or 9·46 kilowatt hours, which is equivalent to 6·3 per cent. of the energy introduced into the furnace. A continuous furnace of the same material and dimensions would have lost 3·5 times as much. In practice the loss is reduced to about twice instead of 3·5 times the magnitude by building thicker walls and altering the conditions accordingly.

The second paper is principally devoted to calculations of relative efficiency. The specific heats at different temperatures of the various materials concerned are first calculated, for carbon and lime (by extrapolation where necessary), from Violle's formula, $S_C = 0{\cdot}355 + 0{\cdot}00006\,t$, and Gin's formula (for atomic heat), $S_{CaO} = 11{\cdot}4 + 0{\cdot}001\,t$, respectively, and for calcium and calcium carbide, with the aid of Kopp's law, as follows: $S_{CaO} - S_O = S_{Ca}$, and $S_{CaC_2} = S_{Ca} + 2S_C$, the atomic heat of oxygen being taken as constant at 4·0. The numbers obtained are as follows :—

Temperature.	Specific Heat of—			
	C.	CaO.	Ca.	CaC_2.
0° C.	0·355	0·2036	0·185	0·247
1,000	0·415	0·2214	0·210	0·271
1,500	0·445	0·2303	0·223	0·296
2,000	0·475	0·2393	0·235	0·325
2,500	0·505	0·2482	0·248	0·344
3,000	0·535	0·2571	0·260	0·363
3,500	0·565	0·2660	0·273	0.381

Using these figures calculations are made in detail to ascertain the actual expenditure of heat in continuous and intermittent furnaces. The final results, including loss by radiation and convection from the furnace-walls, are given in the following table, where *y*, *z*, and *u* represent the respective allowances to be made for the as yet unknown latent heats of fusion of the carbide and lime :—

Carbide containing CaC_2, per cent. (the rest = CaO.	Continuous Furnace.		Intermittent Furnace.		Proportion of the yield of Int. Furnace given by Cont. Furnace per cent.
	K.w. hours per kgrm. CaC_2.	Kgrm. CaC_2 per k.w. day.	K.w. hours per kgrm. CaC_2.	Kgrm. CaC_2 per k.w day.	
100	$3{\cdot}92 + y$	$6{\cdot}1 - z$	2·95	8·1	$75{\cdot}3 - u$
86	$3{\cdot}52 + y$	$6{\cdot}8 - z$	2·62	9·1	$74{\cdot}0 - u$
76	$3{\cdot}25 + y$	$7{\cdot}4 - z$	2·37	10·1	$73{\cdot}5 - u$

These numbers may be considered theoretical maxima, any disturbing causes not here allowed for acting adversely, nevertheless there are cases on record in which they have been very nearly reached in practice. Errors due to ignorance of the exact conditions at the temperatures used, although affecting the accuracy of the numbers themselves, do not influence the comparison between the two classes of furnace, any errors being constant. The teaching of these theoretical figures is confirmed by practice, for while an average of 4·5 kgrms. of 76 per cent. carbide per k.w. day is not exceeded in continuous-furnace work, intermittent furnaces, such as that of the *Deutsche Gold und Silber Anstalt*, give 5·8 to 6·5 kgrms. The fact that those who have tried continuous furnaces are now reverting to the use of intermittent furnaces also confirms this. Finally the author shows that the product of the continuous furnace is not necessarily uniform, nor does the intermittent furnace demand the employment of a larger staff of workmen. W. G. M.

1130. *Apparatus for use in Experimental Fused Electrolysis.* **A. A. Beadle.** (Elect. Rev. 46. pp. 83-84, Jan. 19, and 127–128, Jan. 26, 1900.)—The author gives various forms of crucible furnaces for the purpose of carrying out experiments on fused electrolysis. Simplicity of construction and the utilisation of ordinary appliances easily procurable are aimed at. The furnaces employed are heated by gas, and one also by a Swedish paraffin blow-lamp. Hints as to making good electrical connections for anode and kathode are also given. Altogether the paper contains useful hints for those engaged in this class of work. O. J. S.

1131. *Bromilow's Magnetic Separator for Workshops.* **P. Chevillard.** (Écl. Électr. 22. pp. 177–179, Feb. 3, 1900. Revue Industrielle, xxxi. p. 4, Jan. 6, 1900. Engineer, 88. p. 550, Dec. 1, 1899.)—The machine described in this paper is specially designed for the separation of particles of steel and iron from those of copper, brass, &c., in the refuse turnings and borings from engineering works. The method adopted consists in passing the mixed metal particles from a hopper into a conical shell lying with its axis horizontal. Inside are a number of electromagnets revolving on a spindle and arranged to push the contents forward in the direction of the base of the cone. The magnets after passing through a certain angle are demagnetised by the current being automatically cut off, and allow the adhering iron and steel to drop off into a receiver below through a cavity in the casing. A fixed brush assists this clearing action. The non-magnetisable metals travel forward and are discharged at the end into a separate receiver.

The machine will treat 2 tons per diem. It revolves at 30 revolutions per minute and requires a current of 21 amperes and 7 volts. It weighs about 8 cwt. and requires only about 1 H.P. for revolving and supplying the current. There are drawings in section and perspective illustrating the mechanism. J. L. F. V.

REFERENCES.

1132. *Electrolysis of Alkali-Metal Chloride Solutions.* **H. Wohlwill.** (Zeitschr. Elektrochem. 6. pp. 410–411, Feb. 1, 1900.)—Continuation of discussion referred to in Abstract No. 269 (1900).

1133. *Crystalline Structure of Metals.* **J. A. Ewing** and **W. Rosenhain.** (Roy. Soc., Phil. Trans. 193. pp. 353–375, 1899.)—See Abstract No. 1196 (1899).

1134. *Determination of Transition Temperatures.* **H. M. Dawson** and **P. Williams.** (Chem. Soc., Proc. 15. pp. 210–211, 1899.)—Paper similar to that referred to in Abstract No. 240 (1900). F. G. D.

STEAM PLANT, GAS AND OIL ENGINES.

1135. *Steam Turbines and High-Speed Navigation.* **C. A. Parsons.** (Nature, 61. pp. 424–428, March 1, 1900. Paper read before the Royal Institution, Jan. 26, 1900.)—The author traces the history of the earliest records of the steam engine down to the latest Laval steam turbine. In 1884 the first Parsons turbine engine of 10 H.P., and running at 18,000 revolutions, was made, and is now on view in the South Kensington Museum. As steam was admitted in the centre of the turbines and worked its way out over the guide blades and vanes towards either end there was no end pressure or thrust on the bearings, and the shaft was free to revolve with a minimum amount of friction. The speed of these small turbines was extremely high. In 1888 several 120 H.P. non-condensing parallel flow turbine engines were made and run at much lower speeds. In 1892 the first large radial flow condensing turbine was constructed for 200 H.P. at 4,800 revolutions, driving a 150 kw. alternator. Its consumption was 27 lbs. per kw. hr., or say 16 lbs., per I.H.P. hour. The latest turbo-alternator of 1,200 kw. with 130 lbs. steam, 10° C. superheat, gave 18·8 lbs. per kw. hour, which is equivalent to 11·9 lbs. per I.H.P. hour, and compares favourably with the best reciprocating steam engines.

The most important field for the turbo-motor is that of high-speed navigation, and the *Turbinia* was the first boat built. Great difficulty was experienced from what is known as "cavitation," on account of the extremely high speed of the shaft driving the propellers. Elaborate experiments were carried out to investigate this phenomenon, and led to the deduction that for fast speeds, wide thin blades, coarse pitch ratio, and moderate slip are best suited to prevent cavitation. The one original shaft of the *Turbinia* was now changed for three separate shafts, each carrying three propellers, one behind the other, and 32¾ knots was now reached on the measured mile and a consumption of 14½ lbs. per I.H.P. hour. A special turbine was fitted to one of the shafts for going astern. In 1898 the Admiralty ordered a 31-knot destroyer called the *Viper*. She has four independent screw shafts with two propellers on each shaft. The boilers are of the Yarrow type, with 15,000 square feet H.S. and 272 square feet G.S. The mean speed reached on the preliminary trials was 34·8 knots, the highest run being 35·5 knots with 11,000 H.P., as compared with 6,000 to 6,500 H.P. of the ordinary 30-knot destroyers. The designs for cross channel and other classes of steamers are also briefly dealt with. L. S. R.

1136. *Balanced Piston Valve.* **W. O'Brien.** (Mech. Eng. 5. pp. 256–257, Feb. 24, 1900. Paper read before the Institution of Engineers and Shipbuilders in Scotland, Jan. 23, 1900.)—A comparison is made between an engine of the usual four-crank type, having two piston-valves and two flat slide-valves for the four cylinders, and an engine fitted with cylinders of the same dimensions, having only two Clyde balanced piston-valves and two sets of valve gear for the four cylinders. The latter engine is 5 ft. 3 in. shorter over all. With the abolition of portions of the valve gearing and pipe connections the weight of the engine is considerably less. The combined high-pressure and intermediate-pressure valve has five ports; the top and bottom ports take the boiler steam into the high-pressure cylinder through straight ports at the top and bottom of the cylinder. The exhaust steam from this cylinder passes through the top and bottom ends of the valve into the interior of the valve, and from there it passes through the ports on each side of the middle or exhaust port into the intermediate pressure cylinder. The exhaust from the intermediate pressure cylinder passes into the middle port of the valve, then into the receiver or connecting pipe to the valve for the two low-pressure cylinders. The low-pressure piston valve has only three ports. A. S.

1137. *Corrosive and Incrusto-corrosive Waters in Steam Generators.* **H. de la Coux.** (Écl. Électr. 22. pp. 98–99, Jan. 20, 1900, from Génie Civil, 36. pp. 117, 139, 140, Dec. 23 and 30, 1899, and Jan. 6, 1900.)—Three articles in which the corrosive effects of various substances contained in solution in water are examined, and methods of counteracting them are indicated. Some remedies proposed as preventives of the formation of incrustations have also an anti-corrosive action in the case of waters depositing incrustations which by decomposition become corrosive agents. The author denominates these "incrusto-corrosive" waters. There are also cases in which the remedies proposed against incrustation themselves promote corrosion in boilers using water which deposits innocuous incrustations.

1. Amongst corrosive agents the following are dealt with: HCl and chlorides of magnesium, ammonium, calcium, and sodium; sulphuric acid and sulphates of aluminium and copper; with some general remarks about nitrates, sulphides, sulphurous acid, and H_2S.

2. As remedies against corrosion, notice is taken of the following: Zinc, lime, calcic carbonate, soda, potash, alkaline carbonates, baric hydrate, and carbonate.

The author made special experiments with other substances, such as salts of lead, alkaline phosphates, silicates, and borates to ascertain the range of their action in boilers.

3. The substances proposed as preventers of incrustation are many, some of them being found amongst those named as anti-corrosive agents—these being thus able to perform double functions. The great matter is to select the reagent best suited to the kind of water used. Magnesia, however, should not be thus employed, because of its forming corrosive compounds with carbonate, sulphate, and chloride of calcium.

4. The author concludes that the remedies selected should act equally as regards corrosion and incrustation, not suppressing one action at the cost of favouring the other. For instance, with lime purification can be attained only by an increase of the mass of incrustation; whilst by using magnesia an increase of corrosion may be produced and even a transformation from incrusting to corroding power.

Alkaline carbonates and oxide of barium act perfectly as correctives of incrusto-corrosive waters, because they operate efficiently against both tendencies in the water. F. J. R.

1138. *Dust Destructors and Electric Supply.* **Lauriol.** (Soc. Int. Élect., Bull. 16. pp. 468–484, 1899.)—A detailed estimate of the economy in an electric supply station by the use of dust destructors as a source of energy. The results are worked out for three calorific values of refuse, viz., for 50 kw. hours per ton as in the case of London refuse, for 20 kw. hours as determined in Paris, and for 5 kw. hours, a minimum value. Four conditions of running are considered: (1) When the refuse is burnt and the power supplied uniformly, taking the cost of coal at a halfpenny per unit, there is a saving of

2s., 9d., and 2d. per ton respectively for the three classes of refuse. (2) When the refuse is burnt uniformly and the peak of the load taken by coal firing there results a saving of 0·1d. to 11d. per ton of refuse. (3) When the refuse is burnt as required to supply the load, unless the load factor is very high, the heavy outlay in destructor furnaces required to take the peak results in a loss as compared with coal firing. (4) When accumulators are employed to make the load factor of the plant 100 per cent. a saving of from 1d. to 2s. per ton of refuse is possible. L. B.

1139. *Gradual Variable Speed Gear.* (Engineer, 89. p. 211, Feb. 23, 1900.)—This article describes the general arrangement of a light motor vehicle fitted by Lucas (the inventor) with his expanding pulley gearing. The gear consists of two pulleys, one on the driving and one on the driven shaft, which are constructed with a lattice-work ring of steel strips, lazy-tongs fashion, in such a way that they tend automatically to expand by virtue of a toggle system, actuated by springs. Between the two shafts is a drum, which is connected with both pulleys by means of two belts. The drum is mounted in bearings upon a sliding block. By the action of moving this block towards either one or other of the shafts the one pulley is permitted to expand and the other is compelled to contract. A. G. N.

1140. *Motor Vehicles for Municipal Purposes.* (Automotor Journal, 4. pp. 279–280, March, 1900.)—This is a report giving some of the results of the trials of heavy motor vehicles carried out by the Liverpool branch of the Automobile Club. The report had been prepared by the surveyor for the Chelsea vestry, Mr. T. W. E. Higgens, with a view to the employment of motor dust-collecting vans and for street watering. This report, and one previously written by the same author, shows that although these vehicles cost on an average about £650 each, the work can be performed by them at a lower cost and more quickly than by horses, and the streets kept much cleaner. W. W. B.

1141. *Mees Motor Vehicle.* (Automotor Journal, 4. pp. 267–278, March, 1900.)—The main features of this vehicle are a motor, having two pistons in one cylinder, with pistons moving in opposite directions and connected to cranks at 180° through rocking levers; the engine is enclosed and self-lubricating, and has but one set of valves. On the end of the crank-shaft, which is placed longitudinally in the car, is a bevel pinion always in gear with a pair of bevel wheels, which give a forward or backward motion to the chain pinion shaft by means of two pairs of clutch band brakes, which fix or set at liberty alternatively the one or other of two forward speeds and one speed backwards. The whole of the gear is always in mesh, but the relative velocities of the wheels and pinions that are running idle are not great. The motor is in part air-cooled, water-cooling being adopted for the combustion space. The carburettor is of the surface type, and is placed within the spirit tank. The water is cooled by a group of radiator tubes under the front part of the vehicle. W. W. B.

1142. *Air-cooled Motors.* (Automotor Journal, 4. p. 260, March, 1900.)—This gives the results of certain brake-power tests of a small air-cooled motor, like those used on motor tricycles. The speed of the motor during the tests ranged from 2,090 to 1,710 r.p.m.. and a feeble air-blast was allowed to play upon the cylinder. The tests each lasted ten minutes, and in each case the brake power fell in that time from 2·33 to 2·01 and from 2.28 to 1·65 B.H.P. respectively. In the first case the loss in power in ten minutes was 14 per cent., and in the second case 27 per cent., showing the necessity for better cooling. W. W. B.

1143. *Molas Lamielle and Tessier Compressed Air Delivery Wagon Motor.* **P. Guédon.** (Automotor Journal, 4. pp. 238–239, Feb., 255–257, March, 1900. From "La Locomotion Automobile.")—After a brief description of previous work, this article explains the main features of an air-engine propelled vehicle, in which it is claimed that by using batteries of thin tubes the inventors are able to carry air at a pressure of 290 atmospheres with a weight of vessel of 4·5 times the weight of air. The air reservoirs are divided into two groups—one of six, the other of eleven—containing together about 500 litres, or at the pressure named 178 kilogrammes, the reservoirs weighing altogether 775 kilogrammes. On its way to the motor the air passes through a steel-coil tube ·7 mm. in diameter, 3·5 mm. thick, and 6 metres in length, heated by a mineral spirit burner, raising its temperature to about 150° C. by the consumption of about 500 grammes, or 1·1 lb. of spirit. The air next passes through a pressure regulator reducing valve, on leaving which it has to be again heated by means of a coil similar to the first. The motor has four single-acting cylinders in two pairs, with pistons connected to cranks at 180°, the cranks of one pair being placed at 90° to those of the other. The pistons are fitted with cup leathers, and the exhaust valves are of the mushroom type, the admission valves being small rods with conical ends sitting in coned seats. The valves are worked by a rocking lever at the back of the engine, which receives its motion from cam-operated slotted links, one for giving full movement to the valves and the other for varying the point of cut-off. This arrangement is illustrated. The outlines of results of trials, dated October 2, give weight of vehicle empty as 360 kgs.; load carried, 10 persons; distance traversed, 8 km. = 4·96 miles; time occupied, 1 hour 20 minutes; average speed, 6 km., or 3·72 miles per hour; pressure of air at starting, 136 kgs.; at end of journey, 55 kgs.; fall in pressure, 81 kgs., corresponding to a weight of 48 kgs. of compressed air, or 6 kgs. per km., or per ton km. 1·3 kgs. The cost of air compression is not given. W. W. B.

1144. *Longuemare Carburettor (Heavy Oil).* (Automotor Journal, 4. pp. 260–261, March, 1900.)—This article describes a modification of the Longuemare mineral spirit air carburettor intended for carburation of air by means of ordinary kerosene, or for the evaporation of this oil. Oil is drawn by the movement of the engine piston from the float-regulated feed vessel through a notched mushroom valve form of jet-piece; the fine jets thus produced are carried by the entering air, and are baffled by a perforated plate above the jet-piece, both of which move or may move with every suction stroke of the engine. The body of the carburettor is surrounded by a jacket, which receives the hot exhaust, and descending into the space through which the mixed air and oil vapour passes on its way to the engine is a number of wings heated from the same source. Fluctuation of exhaust thus causes fluctuation of carburettor temperature. W. W. B.

1145. *Oliverson-Killingbeck Variable-speed Gear.* (Indus. and Iron, 28. p. 103, Feb. 16, 1900.)—Variable speed is obtained by the side grip of a belt running between two pairs of slightly coned discs, each pair of which may at will be separated or made to approach each other, the alteration in their distance apart being made so that the surfaces upon which the belt runs are increased and decreased simultaneously. W. W. B.

REFERENCES.

1146. *Economical Generation of Steam Power.* **B. A. Tapp.** (Elect. Engin. 25. pp. 21–23, Jan. 5; 51–53. Jan. 12; 85–87, Jan. 19; 120–122, Jan. 26; 164–166, Feb. 2; and 190–192, Feb. 9, 1900.)—A series of articles on boilers, mechanical stokers, heaters, refuse destructors, &c., giving figures showing the efficiency of the various devices.

1147. *Economy of Economisers.* **A. D. Adams.** (Cassier, 17. pp. 378–382, March, 1900.)

1148. *Oil and Water Separators.* (Amer. Electn. 12. pp. 47–48, Jan., 1900.)

1149. *Feed-Water Heaters.* **G. Halliday.** (Feilden, 2. pp. 149–158, Feb., 1900.) —A description of some types of the above, including heaters by Royle, Weir, Caird and Rayner, Pimbley, &c. Some figures are also given showing the economy of the various devices.

1150. *Radiographic Examination of Coal.* **F. Kotte.** (Eng. Mag. 18. p. 611, Jan., 1900.)—An abstract of a paper that originally appeared in "Stahl und Eisen." The Röntgen rays have been applied to the detection of the presence of slate, pyrites, and other impurities in coal. The latest work has been done by Couriot at the Ecole Centrale at Paris, and some radiographs are reproduced in the original paper that were obtained by Kotte and Aulich.

1151. *Automobile Construction.* **W. W. Beaumont.** (Eng. Mag. 18. pp. 523–529, Jan., 1900.)—A short and general statement of the various developments which have lately taken place in the construction of automobiles.

GENERAL ELECTRICAL ENGINEERING.

1152. *A Dry Accumulator.* **R. Kieseritzky.** (Elekt. Runds. 17. pp. 90–91, Feb. 1, 1900.)—A new material is described for filling accumulators which is said to surpass all previous attempts in the same direction, and for which it is claimed that it renders accumulators of all sizes as convenient to manipulate as dry cells without loss of capacity. At the same time it completely wedges in the plates rendering buckling and any falling out of the active material impossible. No information is given as to the nature of the material employed, and details as to weight of cells per watt or ampere hour of capacity are wanting. The invention is said to have been successfully employed on the tramway between Berlin and Charlottenburg for about two years. R. N. L.

1153. *Glass Insulators.* **Quantin.** (Écl. Électr. 22. pp. 389–390, March 10, 1900. Bulletin des Usines Électriques, No. 24, p. 383, 1899.)—The objections to the use of glass, namely "flying" and attracting water, have been overcome by special annealing and avoiding alkaline constituents. The difficulty of casting produced by the latter precaution has been overcome. Results of laboratory tests are tabulated, showing that in dry and wet weather the glass is from two to ten times better than similar porcelain samples. Under high tension at 7,000 volts no brush discharge occurred with the glass, whereas it did with porcelain, which at 14,000 volts broke down. The glass did not fail at this voltage. M. O'G.

1154. *Substitute for Indiarubber.* **H. L. Terry.** (Electrician, 44. pp. 326–327, Dec. 29, 1899.)—The objections to rubber for deep-sea cables are its porosity and the fact that it is put on in a jointed condition. Substitutes have not the tensile strength or resilience of rubber. Resinous bodies favour less the diffusion of liquids and gases than indiarubber, hence the superiority of guttapercha for submarine work. Admixture of rubber with bodies made from rape oil by the action of sulphur renders these bodies sufficiently soluble in naphtha to make a varnish. In this way rubber adds to their utility. Although water is objectionable in cable rubbers, several per cent. of water as shown by the chemical test may be present without detriment. M. O'G.

1155. *Indiarubber for Cables.* **O. Schaefer.** (Electrician, 44. pp. 426–427, Jan. 19, 1900.)—When applied in the "longitudinal" machine the join effected by vulcanisation is indistinguishable. Only poor rubbers heavily loaded can be extruded through the "die" machines. Where there is damp in the iron cable conduits, &c., all rubber should be lead-covered. The author thinks rubber will be largely used for high tension transmission. M. O'G.

1156. *Automatic Pressure Regulator.* **E. Dick.** (Elektrotechn. Ztschr. 21. pp. 80–83, Jan. 25, 1900.)—This regulator comprises a solenoid with a longitudinally guided core having at its upper end a rack which gears with a pinion on a shaft having an adjustable weighted arm. The lower end of the core extends into a chamber formed by a series of iron rings insulated from each other by micanite rings and containing mercury. The iron rings are connected to resistances, so that when the iron core is in its lowest position, it acts as a displacer and causes the mercury to rise in the chamber and short-circuit all the resistances; as the core rises, by the attraction of the solenoid, the mercury sinks and the short-circuit is successively removed from the several resistances. The theory of the instrument is very fully discussed mathematically, as well as its application to direct- and alternate-current dynamos. C. K. F.

1157. *Earthing Device.* **G. Stern.** (Zeitschr. Elektrotechn., Wien, 18. pp. 29–30, Jan. 14, 1900.)—A simple device was used on the Vienna network in 1892 for earthing the outer of concentric cables in case their potential rose above that of the earth. It consists of a spark-gap connected between the outer and earth. This gave trouble by the fusing of the toothed metal faces of the spark-gap. To overcome this, an automatic short-circuiting switch is used, held open by a fusible wire which is joined in series with the spark-gap. If the outer of the cable becomes charged, an arc is struck in the spark-gap, the fuse blown and the switch automatically closes, effectually connecting the cable to earth. L. B.

1158. *Wiring.* **W. A. Chamen.** (Electrician, 44. pp. 512–514, Feb. 2, 1900. Abstract of paper read before the Institution of Engineers and Shipbuilders, Jan. 23.)—Wiring in wood casing is unsatisfactory owing to the want of sufficient protection. Lead-covered systems are damp proof, but no safer mechanically. The lead should be well earthed. The most reliable wiring is carried in iron pipes, either plain or coated internally with insulating material. Great care must be taken to avoid damage in drawing in. The system is expensive, but might be greatly cheapened by the standardisation of boxes, switches, joints, &c.

The earlier and simpler form of house wiring is on the tree system. But the large number of isolated fuses necessary is a great drawback. The more recent and safer method is the distribution board system. The fuses are all on one or two boards and are easily found and replaced. Bunching of the leads behind the distributing boards is to be avoided if possible. A reasonable compromise consists of a number of small distribution boards connected to the mains by a tree system. L. B.

1159. *Aluminium as an Electrical Conductor.* **J. Guillaume.** (Écl. Électr. 22. pp. 321–328, March 3, 1900.)—This article is a summary of the facts and figures contained in articles on the same subject, by C. T. Child in the "Electrical Review," New York (see 1900, Abstract No 316); by J. B. C. Kershaw in "Lightning" (see 1899, Abstract No. 1768); and in the "Journal of Electricity, Power, and Gas," vol. 8. No. 1.

The tables relating to the relative cost, weight, strength, &c., of wires of copper, aluminium, bronze, and steel, given in the last-named paper, have been reduced to the metric system, and are reprinted in full. These tables form the chief portion of the article. J. B. C. K.

1160. *Aluminium Transmission Line at Hartford.* (Elect. Rev. N.Y. 36. pp. 116–117, Jan. 31, 1900.)—Some particulars are given of the overhead transmission line between Farmington River Power Station and Hartford, Ct.

The line is 11 miles long, consists of three aluminium cables of 342,000 circular mils, area, and it transmits about 2,000 H.P. by three-phase currents. In all over 60,000 pounds of aluminium were used. The specifications under which the wire was furnished were very rigid. The aluminium was required to have an ohmic resistance, at 75° F., not greater than 0·05057 ohms per thousand feet. The tensile strength was guaranteed as not less than 27,700 pounds per square inch, with an elastic limit of one-half this amount. The wire was guaranteed capable of being wrapped six turns around its own diameter, unwrapped and again wrapped six turns around its own diameter in the same direction as at first, without showing any cracks. The composition was guaranteed not less than 99·6 per cent. pure aluminium.

The wire consisted of seven strands, each of approximately 48,800 circular mils., that is, with a diameter of nearly three-quarters of an inch. With this size of cable it was found impossible to use the ordinary McIntire joint. This joint requires no solder, the two ends of the wire being placed in a slightly flattened tube and then six or seven twists given to the tube. It can be successfully used in seven-strand cable which does not exceed half an inch in diameter. The joints for this heavier cable were of the sleeve type. The sleeve, about 7 inches long, was made with a slightly larger inside diameter in the centre than at the ends. The wire was spread so that when forced into the sleeve the strands were very close to the inside wall and the sleeve was run in with a solder consisting of pure block tin with a little phosphorus to give increased fluidity. The inside of the sleeve was tinned and also the strands of the cable; the aluminium was easily tinned by using hydrofluoric acid to clean the wire. To avoid any possibility of electrolytic action at the exposed ends of the joint, the ends were covered with white lead. The poles were spaced 100 feet apart and the sag for this distance was calculated with a safety factor of 3 at —20° F., and will amount to not more than 15 inches at 120° F. Official tests have been made by the Hartford Electric Light Company, and the guarantees have been fully equalled and in some cases exceeded. E. D. P.

1161. *Design of Buildings for Electricity Works.* **A. Roberts.** (Mech. Eng. 5. pp. 245–247, Feb. 17, 1900. Abstract of a paper read before the Society of Architects, Jan. 25; also Electrician, 44. pp. 510–512, Feb. 2, 1900.)

Selection of Site. Many matters of vital importance to the ultimate economical working have to be considered. It should, if practicable, be near a river, canal, or railway to prevent the necessity of cartage, which involves a large extra outlay each year. The centre of a large residential neighbourhood should be avoided on account of complaints as to alleged vibration, noise, smoke, condensed steam, &c., and also possible actions for damage to ancient lights.

It is false economy in the first place not to acquire a large enough site for all contingencies of extension and growth which may be anticipated for many years to come. Concerning the design and construction of the buildings, the ideas and wishes of the electrical engineer should be always studied and adopted by the architect, and the plan of necessity depends, to a large extent, upon the shape of the site, but simplicity and economy of working should be the keynote.

The following are the principal departments for which provision must be made in the plan: (1) Coal stores; (2) Boiler-house; (3) Engine-house; (4) Workshops; (5) Stores; (6) Meter and testing-rooms; (7) Engineer's apartments; (8) Offices; and also battery-rooms if required.

Coal Stores. These should be readily accessible from the boiler-house, and should be divided into a number of bunkers, to obviate danger of fire and for other reasons; one to each pair of boilers is a convenient arrangement, so that a check may be kept upon the consumption per boiler. As to capacity of coal vaults, sufficient coal should be accommodated to supply the boilers for at least three weeks or a month, the greater the amount of coal storage capacity the better.

Boiler-house. A convenient arrangement is for the boiler-house, where practicable, to run parallel with the coal bunkers, also with the engine-house. It is usual to sink the level of the boiler-house floor some 8 to 10 feet below that of the engine-house, so that the steam-pipe from the crown of the boilers may be conveniently placed with regard to the engine, also so that coals may be shot down from the ground level into the coal bunkers beneath. A space of 16 to 18 feet at least should be left between the boiler and wall opposite fire-door for convenience of stoking and other considerations. Good ventilation and illumination are of importance. Spaces should be provided for all boiler-house accessories and also for stoker's mess-room, with cooking range, &c.

Chimneys and Flues. In selecting position of shafts future extensions must be borne in mind. It is best to place it in the centre of the range of boilers, with the horizontal flue running right and left thereof, so that boilers may be added as the works grow.

It is however advisable, where funds and space permit, to have two shafts of smaller capacity rather than one shaft of larger capacity, so that in event of repairs being necessitated through damage, one may be shut down whilst the other is working. The area of the shafts should also be amply large enough to provide for all future boilers that may be required, and it is advisable to carry up the shafts at least 150 to 200 feet, so as to distribute the products of combustion at as high a level as possible. The usual form of chimney chosen for electrical stations is an octagonal form of unequal sides, or rather a square chimney with the corners cut off ; there is, however, a diversity of opinion as to the best form. Particulars are given as to the correct sectional area to adopt both for the chimney and the flues, and also as to foundations and construction concerning the former. In most electrical generating shafts the exhaust steam-pipe is carried up the centre of the shaft, and as this pipe and the heated column of steam inside forms the readiest path for a flash of lightning, it must be carefully earthed and connected up to the lightning conductor.

Engine-house. It is essential not only for the personal comfort of the staff, but also for the plant, that the temperature should not be too high. The author has found that a good flooring consists of unglazed red tiling, although this has the objection of not being a good insulating material. Reference is made to methods adopted in the engine foundations to prevent transmission of vibration.

That adopted at the Chelsea station, which has proved very satisfactory, is to first construct a foundation of concrete 9 inches deep ; on this sheet lead is placed, then two layers of continuous matting similar to an ordinary door-mat but very much thinner ; on this lead sheeting is again laid, and on these insulating layers the concrete superstructure of the engine bed, about 7 feet deep, is erected.

Particulars are also given concerning the workshops, stores, metre and testing-rooms, engineer's apartments and offices. It is advised that accommodation should be provided on the roof, in some convenient and accessible position, for water tanks, as a large storage of water is essential, so that in the event of burst mains or other cause preventing supply, no inconvenience is occasioned.

Finally, it is advised that a system of fire hydrants should be fitted throughout the building. All walls (at any rate, those of the engine-house) should be carried down to same level as foundations in engine beds, and a clear space should be left all round the building between external walls and those of adjoining buildings, to prevent transmission of any vibration.

L. J. S.

1162. *Electrical Lifts and Cranes.* **F. Niethammer.** (Elektrotechn. Ztschr. 21. pp. 33–38, Jan. 11, 55–60, Jan. 18, 1900.)—In this paper the author first describes graphical methods of determining the acceleration, time of a complete lift, and other quantities, from the curves giving the relation between the torque and the speed, the speed and the time, and the current and the time. Methods are also given for comparing the relative efficiencies of different motors for particular work. The question of the most suitable generator and motor is then discussed, together with the best arrangement of resistances and controlling apparatus. A number of examples of brakes and reversing mechanisms are described, together with the counter-balance systems of Sprague and Fuller-Fraser. Several examples of travelling-cranes for workshop and dock use are then described with reference to working drawings. C. K. F.

1163. *Storage and Transfer of Energy by Calcium Carbide.* **E. Neuberg.** (Elektrotechn. Ztschr. 21. pp. 172–174, March 1, 1900.)—The author compares the change of the kinetic energy of a waterfall into the chemical energy of calcium carbide, to that occurring when a secondary cell is charged from a similar source of electrical current. The calculations made by the author in the course of his paper are based upon the charges for current made by the Berlin "Elektricitäts Werke," which are equivalent to 18·5 pfg. per 1,000 kg. cal. when used for motor purposes, and to 63·6 pfg. per 1,000 kg. cal. when used for lighting. Taking carbide at 35 M. per 100 kg., the same amount of energy from this source will cost 16·65 pfg. Using these costs data, the author calculates the following ratios for the various purposes to which electricity and acetylene gas may be applied :—

Lighting, per c.p. hr.	Electricity, 0·151 pfg. ...	Acetylene, 0·120 pfg.
Heating, 1350 g. water heated 30–92° C.	„ 1·88 „ ...	„ 2·74 „
Motors, per H.P. hr.	„ 14·55 „ ...	„ 35·1 „

The author sums up by stating that the thermochemical data show calcium-carbide to be more satisfactory than electricity as a carrier of energy ; but because electrical apparatus and machinery is of high efficiency calcium carbide cannot compete with electricity except for lighting purposes.

J. B. C. K.

1164. *Lift Gear.* (Elect. Engin. 25. pp. 8–9, Jan. 5, 1900.)—In a new lift devised by the Electric Construction Co. there are two driving drums, revolving in opposite directions, and the ropes supporting the cage pass over one and under the other drum, thereby preventing slip. The drums are driven by right- and left-handed worms, whose thrusts counter-balance one another. The motor is connected to the worm shaft by a claw coupling having 90° play. If the load tends to drive the motor, a resistance in the field is short-circuited by the motion of a disc along a screwed portion of the shaft when the claw turns through its 90° play. Should the supply mains be incapable of taking the current thus generated, a powerful friction brake, normally held off by a shunt-coil, comes into operation. The motor is started up through a resistance, the cutting out of which is not under the control of the driver, but is performed by a switch-bar diven by an oscillating lever from an eccentric on the motor shaft. This lever carries a pawl actuated by a magnet, which, when all the resistance is cut out, is short-circuited, thereby keeping the pawl out of action. The switch-bar is retained by a band-brake operated by a magnet, and when the circuit is broken it returns to the "all-resistance-in" position, while at the same time the motor is short-circuited upon itself through a fixed resistance, and the friction brake is applied. E. H. C.-H.

REFERENCES.

1165. *Electricity in Mining and Handling of Bituminous Coal.* (Amer. Electn. 11. pp. 299–300, 1899.)—Describes the latest forms of mining locomotive, coal-cutting machines, and electric rotary drills used for mining soft coals, built by the Jeffrey Manufacturing Company, of Columbus, Ohio. The article is illustrated, but no technical information is given. Ll. B. A.

1166. *Comparative Advantages of Electricity, Steam, and Compressed Air for Mining Purposes.* **W. E. Garforth.** (Inst. Civ. Engin., Proc. 138. pp. 436–439, 1899; also Engineer 87. p. 641.)

1167. *Applications of Electricity to Cranes and Hoists at Cripple Creek, Colorado.* (Elect. Rev. 45. pp. 847–848, Nov. 24, 1899; also Engineering and Mining Journal.)

1168. *Seasoning of Wood by Electricity.* **J. A. Montpellier.** (Electricien, 18. pp. 237–239; pp. 255–258, 1899.) Illustrated description of the method of Nodon and Bretonneau. — (pp. 273 - 276) Applications of wood so seasoned, and also particulars of preparation of wood for special purposes, non-inflammable, extra durability, colouring, and the removal of bark.—(pp. 304–306, Nov. 4) Works at Aubervilliers.—(p. 314, Nov. 11) Description of vats and heating stoves.—(pp. 333–335, Nov. 18, 1899) Costs and general advantages of process.

1169. *Traction Accumulators.* **J. Reyval.** (Écl. Électr. 20. pp. 94–98, 124–126, and 336–337, 1899.)—Description of cells. Remarkable details of a test on a Plante type of battery made by Ranun de Souza. M. O'G.

1170. *Interior Alternating Current Wiring.* **R. W. Lohmann.** (Elect. World and Engineer, 34. pp. 612–614, 1899.)—This paper contains instructions for wiremen to determine the impedance drop in an alternating current circuit of known ohmic resistance, the wires of which are at a given distance apart and which carry a known current of given frequency. The instructions refer to the tables given by A. E. Kennelly in the Transactions of the American Institute of Electrical Engineers, vol. x.

An elementary explanation of the "skin effect" is also given. W. G. R.

1171. *Cost of Central Station Plant.* (Elect. Rev. 45. pp. 787–788, Nov. 17, 866–867, Nov. 24, and 946–947, Dec. 8, 1899.)

1172. *Electricity in Hat Manufacture.* (West. Electn. 25. pp. 89–90, 1899.)—An illustrated description of the application of electric heat and power to the manufacture of hats.

1173. *Electricity in Japan.* (Elect. World and Engineer, 34. pp. 849–850, Dec. 2, 1899.)—An article dealing with the progress of telephony, telegraphy, electric lighting and general electrical engineering in Japan.

GENERATORS, MOTORS, AND TRANSFORMERS.

1174. *Three-Wire Distribution from a Single Dynamo.* **E. Bretch.** (Elect. World and Engineer, 35. pp. 58–59, Jan. 13, 1900.)—In order to operate a direct-current three-wire system from a single dynamo, the middle wire must be connected to the armature winding in some manner. This connection may be made at one or more points symmetrically disposed by means of slip-rings. In order to avoid alternating currents through these slip-rings, their connections are carried, before joining the middle wire, through choking-coils, whose self-induction does not affect the balancing direct-current. To avoid interference with the commutation at the main brushes, the middle wire should be connected to a large number of points in the armature-winding, but for simplicity of design three are found to be sufficient. L. B.

1175. *Parallel Working of Direct-Coupled Alternators.* **W. L. R. Emmet.** (Elect. World and Engineer, 35. pp. 95–96, Jan. 20, 1900.)—A description is given of a dash-pot used to control the action of an engine governor. The dash-pot is so designed as to be very sluggish for brief intermittent alterations in speed, though yielding freely to any continued change, such as would be produced by a change of load. The main piston of the dash-pot has first to move a small subsidiary piston, which then opens a passage allowing free motion of the oil filling the pot. Governors controlled by such means appear to give satisfactory results in practice. W. H. E.

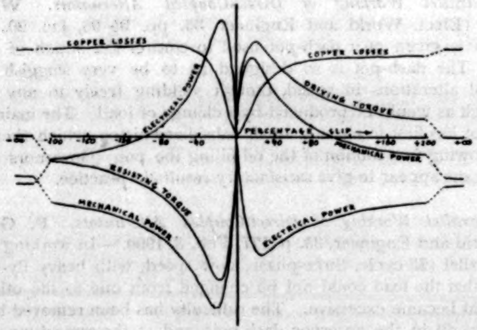
1176. *Parallel Working of Direct-Coupled Alternators.* **F. G. Sykes.** (Elect. World and Engineer, 35. p. 177, Feb. 3, 1900.)—In working two large sets in parallel (25-cycle, three-phase, slow speed, with heavy fly-wheels) it was found that the load could not be changed from one to the other, as the cross-current became excessive. The difficulty has been removed by using a more viscous oil in the governor dash-pots, and at the same time arranging that the engine speed should be controlled by the switchboard attendant. The latter condition is secured by using an electric motor to act on the governor, the motor being controlled from the switchboard. This speed control is found to be very useful in throwing the sets into parallel, and is further employed in changing the load from one set to the other; while the cross-current is eliminated by suitable regulation of the field excitation of the two alternators. W. H. E.

1177. *Tests of Multiphase Alternators for the Cusset Generating Station.* **J. L. Routin.** (Écl. Électr. 21. pp. 441–451, Dec. 23, 1899.)—The tests were made by the Behn-Eschenburg method, in which the power of the driving motor need not be more than 10 or 20 per cent. of the output of the alternator. By a simple graphical construction this method permits the determination of the voltage at the alternator terminals running on an inductive circuit as a function of the exciting current. The article is well illustrated, and there are sixteen tables giving results of tests. E. K. S.

1178. *Design of Monophase and Polyphase Generators.* **B. A. Behrend.** (Elect. World and Engineer, 35. pp. 90–92, Jan. 20; 125–127, Jan. 27, and 166–

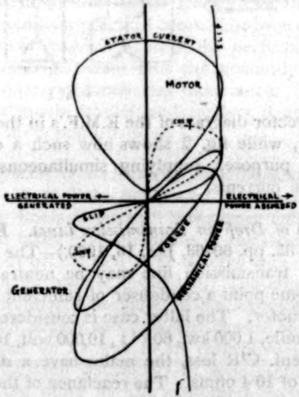
168, Feb. 3, 1900.)—The author discusses the various points affecting the design of alternators, and condemns inductor alternators as unsatisfactory on account of the high leakage of lines between field and armature. The question of frequency is one which also should be considered when designing an alternator, as some machines work better than others at a particular frequency. The best frequency for a given machine depends upon the dimensions of the pole-pieces. W. G. R.

1179. *Theory of Induction Motors.* **J. Heubach.** (Elektrotechn. Ztschr. 21. pp. 73–78, Jan. 25, and pp. 97–101, Feb. 1, 1900.)—In a former communication (see 1899, Abstract No. 1976) the author considered the application of the Heyland diagram to the study of induction motors under normal conditions of working. In the present paper, the results then arrived at are extended to include slips ranging from $-\infty$ to $+\infty$. As the author points out, it may happen that under ordinary conditions of working a motor is made to run with a negative slip, or with one exceeding 100 per cent. Such cases may arise in the working of cranes which have accidentally been overloaded, or in the case of tramcars running down an incline. Making use of the Heyland diagram, and then plotting the results in rectangular co-ordinates, the author arrives at the set of curves given below, which show how the various quantities involved vary as the slip changes from $-\infty$ to $+\infty$. The second part of the paper deals with single-phase motors, the single-phase motor being supposed to be replaced by an equivalent pair of polyphase motors. Curves similar to the above are given for the single-phase motor. In the concluding portion of the paper, the author explains how the Heyland diagram must be modified so as to include the hysteresis and eddy-current losses. A. H.



1180. *Rotary Converters.* **J. Herrmann.** (Elektrotechn. Ztschr. 21. pp. 60–61, Jan. 18, 1900.)—The rotary converters employed in practice in spite of recent improvements are still at least as expensive in manufacture as direct current generators. The object of the separately excited magnetic system is not to generate an E.M.F. in the winding as in the dynamo, but merely to keep the armature rotating in phase with the alternating E.M.F. If the armature were driven by a separate synchronous motor the field poles might be replaced by a simple iron ring, though this would involve the loss of the regulation of power factor which is rendered possible by varying the excitation of converters. The machine might be further simplified, first by replacing the fixed field ring by a radial extension of the armature core beyond the holes for the winding, and then by keeping the whole armature fixed and rotating the brushes. Such a machine made at the Stuttgart Technical Institute is described. The arrangement of Hutin and Leblanc is derived from this by connecting the winding of the fixed armature by means of slip rings to the bars of a rotating commutator. The armature can also combine the function of a static transformer if provided with two windings, and can then be used either as a converter or as a polyphase transformer. L. B.

1181. *Theory of Induction Motors.* **Heyland.** (Elektrotechn. Ztschr. 21. p. 146, Feb. 15, 1900.)—Referring to Heubach's article on this subject (see Abstract 1179), the writer points out that the results obtained by him may be graphically exhibited in a much more striking form by plotting the various quantities involved, not as functions of the slip (see curves of Abstract 1179), but as functions of the electrical power supplied to, or developed by, the motor. The diagram here reproduced shows the elegant construction which is then arrived at. A. H.



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1182. *Theory of Armature Windings.* **C. Richter.** (Zeitschr. Elektrotechn., Wien, 18. pp. 8–13, Jan. 1; 32–36, Jan. 14; and 67–75, Feb. 4, 1900.)—An elaborate discussion of the conditions which must be fulfilled in various cases in order to render a closed winding possible. A. H.

1183. *Commutation in Dynamos.* (Elect. Rev. 46. pp. 43–45, Jan. 12; 86–87, Jan. 19; 211–213, Feb. 9; and pp. 299–300, Feb. 23, 1900.)—Papers of a mathematical nature, dealing with questions of design, and recent contributions to the subject.

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

1184. *Transformations of Polyphase Systems.* **C. F. Scott.** (Zeitschr. Elektrotechn., Wien, 18. pp. 13–14, Jan. 1, 1900.)—By means of a single auto-transformer, the author effects the transition from two-phase to three-phase

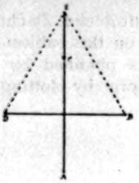

FIG 1

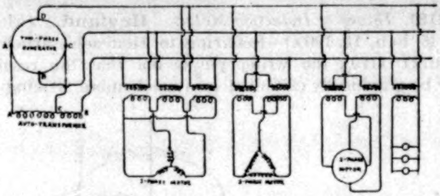

FIG. 2

currents. Fig. 1 is a vector diagram of the E.M.F.'s in the two-phase generator and auto-transformer, while fig. 2 shows how such a combination may be used for distribution purposes, supplying simultaneously single-phase, two-phase and three-phase currents. A. H.

1185. *Compensation of Drop on Transmission Lines.* **E. J. Berg.** (Elect. World and Engineer, 35. pp. 60–63, Jan. 13, 1900.)—The drop in voltage over an alternate current transmission line may be neutralised by connecting across the mains at some point a condenser of sufficient capacity or an over-excited synchronous motor. The latter case is considered in detail by means of an example of a 20-mile, 1,000 kw., 60 ∿, 10,000 volt, 100 amp. transmission. Allowing a 10 per cent. C^2R loss, the mains have a diameter of 0·46 inch and a total resistance of 10·4 ohms. The reactance of the line,

$$pL = 2\pi \sim \times 80{\cdot}5\,(2 \log_e 2s + \tfrac{1}{2})\,10^{-6},$$

where s = ratio of distance between the wires to the diameter of either. Taking 18 inches as the distance between the wires, $pL = 22{\cdot}5$ ohms and the impedance $z = \sqrt{R^2 + p^2L^2} = 24{\cdot}8$ ohms. Under these conditions the drop in the line is 13 per cent. To balance this drop, a leading wattless current of

$$\frac{EpL}{z^2} - \sqrt{\frac{E^2p^2L^2}{z^4} - C^2 - \frac{2ECR}{z^2}}$$

is required, where C is the useful current. In the above example this gives a leading current of 66 amperes. To supply this an over-excited synchronous motor of at least 660 kw. would be required running light. By making it slightly larger, a large proportion of its rated load can be taken off as power without neutralising its boosting effect. Curves are given showing the effect of placing the motor at different points of the line. The size of motor to give an over-compounding effect at the far end of the line is also calculated. If a fixed percentage drop is allowed in the line, the size of the regulating motor may be reduced and it will be called upon to supply lagging currents at light load and leading currents at full load, obtained by varying the exciting current. Calculations are given in full. L. B.

1186. *Graphical Calculations for Three-Phase Concentric Underground Mains.* **C. E. Guye.** (Écl. Électr. 22. pp. 83–87, Jan. 20, 1900.)—The author shows how to construct a geometrical figure representing the currents, voltages, and phase differences occurring in a three-phase concentric underground line conveying power. To simplify the problem the capacity between adjacent conductors is assumed to be concentrated at the middle of the cable, and the self-induction of the conductors is in the first instance neglected. There are three capacities considered, the two on each side of the intermediate conductor, and the third between the outer conductor and the protecting sheath. No numerical calculations are given, but the figure indicates how the cable may cause distortion from the symmetrical conditions of supply of the three-phase current. A second, and more elaborate, diagram is shown in which the modification due to self-induction in the line conductors is considered.

In view of the fact that the capacity of the cable is distributed along its entire length, and also because actual alternating currents are not purely sinuous, but possess harmonics of higher frequencies, the author points out that no figure can be precise for practical cases. The important question which has to be decided in actual cases is whether the perturbations caused by the cable are of appreciable magnitude. This can generally be done by neglecting the effect of the line resistance and inductance. The diagram under these circumstances is much simpler, and renders it easy to calculate the order of magnitude of these perturbations. W. E. S.

1187. *Electric Equipment of a Printing Establishment.* **G. A. Damon.** (Amer. Electn. 12. pp. 67–69, Feb., 1900.)—An illustrated description of the equipment of the "St. Louis Republic" Newspaper Offices for both power and lighting. Power is taken from the mains of the local electric light company, which supplies direct current over a three-wire system at 470 volts across the outers, with the neutral grounded. The current passes into the building through a switchboard provided with a separate switch for each of the nine circuits which supply the different classes of service. From the switchboard each circuit on its way to its respective part of the building passes through two Thomson wattmeters in series—one wattmeter for the supply company and the other for the customers, each acting as a check upon the other. These wattmeters in *each* circuit furnish a ready means of checking the cost of power used by each department, and of suggesting measures for obtaining greater economy.

In connection with the motor equipment the application and the speed control of the press motors was the most serious problem. The printing of the paper requires three Hoe quadruple presses, each capable of printing 24,000 papers per hour. The main driving shaft of each press turns 200 times a minute, and is driven by gearing from a 40-H.P. four-pole motor running at 700 r.p.m. The method of speed control adopted is the combination of armature resistance, field regulation, and the "teaser" system as developed by the Crocker-Wheeler Company. In operating newspaper presses it is essential to provide five or six *very slow* speeds to be used in adjusting the presses and in threading through the paper while "making ready" to run an edition. In doing this work the press attendants become familiar with certain speeds, and any variation not only hinders them in their work, but is also liable to prove dangerous to the hands, who are trained to certain motions. The slow speeds must therefore be constant, and they are secured by the use of a "teaser," or small motor generator, running at constant speed, the motor end taking its current from the 470-volt mains, while the generator end delivers current to the press motor at a potential varying between zero and 80 volts. In this way a range of very low constant speeds is obtained, the higher speeds being obtained by throwing the press motor direct on to the 470-volt mains through a resistance. Normal full speed is attained when this resistance is cut out, and speeds above normal are obtained by slightly weakening the field strength of the press motor itself. The controller is provided with a solenoid magnet circuit breaker, which opens the circuit automatically in case the line voltage fails. This circuit breaker can also be operated from any one of six push buttons distributed at convenient points about the press frame. A band-brake actuated by means of a spring, and controlled by a solenoid magnet in series with the main circuit is provided, which applies itself instantaneously to gradually stop the press in case the line circuit fails, or any one of the stop buttons is pushed in an emergency.

Descriptions are given of the various other applications of the motors to the 20 Linotype machines, ¼-H.P. motor to each; Matrix rolling machine, 2½-H.P. compound wound motor; Tail-cutting machine, 4-H.P. motor; Shaving machine, 4-H.P. motor; Carriers for presses, three 1-H.P. motors; Blower for the pneumatic tube, 5 H.P. motor. Besides these there are motors for the freight lifts, passenger elevators, &c., and in the art department a ½-H.P. motor to operate the rocking device of the acid bath; ½-H.P motor belted to the rotor; and a 2½-H.P. motor belted to the saw and trimmer. The composing-room and the stereotype-room are also equipped with a motor-driven saw and trimmer similar to the one in the art department.

The indirect advantages of electrical operation were well demonstrated in this plant; for example, in arranging the equipment, the placing of the separate machines was not determined by the position of a line shaft, and full advantage was taken of this fact. Again, in planning the stereotype room the machines were not placed at right angles, as is usually the case, but were set in positions which would reduce the number of steps and motions of the workmen to a minimum. The building is fireproof throughout, and in arranging the rooms the architect was not handicapped by the necessity of providing shaft pits or belt ducts, with the consequent dangerous openings through walls and floors. The evenness of the power obtained from the press motors, the wide range of available speeds, and the convenient method of control, have proved most beneficial. E. K. S.

1188. *City Road and Wandsworth Supply Stations of London.* (Elect. Engin. 25. pp. 258–266, Feb. 23, and 294–303, March 2, 1900.)—The two stations of the County of London and Brush Provincial Company at City Road and Wandsworth are described in detail. The former was opened in 1897. The system originally employed was a single-phase 100 ∿ for light, and 530-volt continuous current for power. In making extensions in 1899 a two-phase 50 ∿ system was employed, the ultimate intention being to replace the single-phase plant altogether. The single-phase plant consists of six 180-kw. Mordey alternators and Brush engines, the two-phase of six 200-kw. E.C.C. alternators and Brush engines. The direct current is supplied by two 550-kw. General Electric dynamos and Allis engines. A battery and transformers are employed, allowing all three systems to be supplied from any single generating set at periods of light load. At the Wandsworth station the plant consists of six 2,000-volt 100 ∿ 180-kw. Mordey alternators, driven by Raworth Universal engines. Three of the feeders from this station are thirteen miles long, and for these the pressure is transformed up to 6,000 volts. As in the City Road station, it is intended here also to change over to a 50 ∿ two-phase system ultimately. Babcock boilers, Green's economisers, and Ferranti switchboards are employed at both stations. Details are given of the distributing network, also illustrations of the plant and load curves taken under various conditions. L. B.

1189. *Tests of Steam Alternators at Zurich.* **H. Wagner.** (Elektrotechn. Ztschr. 21. pp. 147–151, Feb. 22, 1900.)—A detailed account is given of tests of the boilers, engines, and alternators recently installed at the central station supplying the town. The boilers, seven in number, were made by Escher, Wyss & Co., and are of a composite type. Each consists of a lower boiler of the Lancashire type, connected with an upper boiler which is multitubular (fire-tubes). The lower shell measures 16 ft. 5 in. by 7 ft. 9 in., and the upper 12 ft. 10 in. by 7 ft. 2 in. The latter has 106 wrought-iron welded tubes (3¾ inches), and is fitted with a steam dome. Two tubes connect the boilers, the one to take steam to the upper boiler from the lower, and the other to supply water to the lower from the upper. The lower boiler can also be fed direct. A Schwörer superheater is fitted in the flue between the two boilers. The grate area is 35 square feet, and the heating surface 1,940 square feet. The fuel used is coke, and the working pressure 125 lbs. per square inch. Some of the results of the trials are appended :—

Water evaporated per lb. (gross) of coke	15·3	lbs.
„ „ per square foot of heating surface per hour	2·0	„
Coke burned per square foot of grate area per hour	16.0	„
"Efficiency" of boiler	75·2	%

The engines are tandem compound condensing, by Sulzer, with valve regulation. They were guaranteed to give 1,160 I.H.P. and 1,000 effective H.P. with cut-off at 0·28 in the high-pressure cylinder, and 1,370 I.H.P. and 1,200 effective H.P. with cut-off at 0·40 ; with 117 lbs. steam pressure and speed 100 r.p.m. At a trial made with 1,167 I.H.P., the weight of water used per I.H.P. per hour was 13·1 lbs. The effective H.P. was taken as $1{,}167 - (57 + 44)$, 57 being the I.H.P. at no load, and 44 being allowed for additional friction at full load, viz., 4 per cent. of the load. This gives an efficiency of 91·3 per cent. In this test the friction of the alternator was included. (H.P. here used = English H.P. less 1·4 per cent.)

The alternators are three-phase machines of the Oerlikon inductor type, each being direct coupled to its engine, with the inductor acting as a flywheel. They can be used as single-phasers by putting two of the windings in series and switching out the third. The armature of the exciter is mounted on the shaft of the alternator, and in some of the tests was used to drive it in order to find the iron losses and friction, the engine being uncoupled.

Guaranteed output, with power factor = 0·85, 1,200 kilovolt-amperes ; pressure, 2,000 volts ; periodicity, 50 ; speed, 100 r.p.m. ; total weight, 40 tons ; weight of rotor, 26½ tons ; diameter, 15 feet.

After a run of 8½ hours with a water-resistance load of 750 kw., the greatest temperature rise was 19° C. in the armature. The exciting current required was 42 amperes at 26 volts ; for a large inductive load this has to be increased to 120 amperes. The efficiency of the set, with 750 kw. load, was 88 per cent. (ratio of effective E.H.P. to I.H.P.). Friction losses of alternator, 16 kw., or 1·6 per cent. of full load ; iron losses, 22·5 kw. Total excitation losses, 4·8 kw. With 350 amperes the calculated C^2R loss in the armature = 24 kw. (R for one limb being 0·067 ohm); by tests this loss was found to be 27 kw., including eddy losses. With a load of 940 kw. at 2,000 volts and power-factor = 0·8, the efficiency of the alternator was 93·5 per cent., including friction losses; and with a non-inductive load of 750 kw. the efficiency was 93·8 per cent.

The two alternators were switched in parallel without difficulty, with any load, and ran in parallel without a trace of hunting.

Taking the efficiency of the set as 88 per cent., the coke used per kw. hour was 2·9 lbs. In daily work on the town load the average fuel consumption for three months (September to November) has been 4·6 lbs., of which 8 per cent. was coal.

The average evaporation has been 14·6 lbs. of water per lb. of fuel, although most of the coke was unusually moist. With fairly dry coke the results are expected to be 10 per cent. better.

The paper concludes with a brief description of three 200 kw. Oerlikon motor generators, which are used for feeding part of the town tramways from a substation. Each consists of a three-phase 1,950 volt motor coupled to a four-pole 550 volt dynamo. The efficiencies of conversion at quarter, half, and full load respectively are 75, 85, and 88 per cent., the apparent efficiencies being 55, 72, and 79 per cent. W. H. E.

1190. *Chambly Transmission Plant.* **E. M. Archibald.** (Canad. Elect. News, 10. pp. 1–6, Jan., 1900.)—The transmission of electrical power from Chambly to Montreal was inaugurated in June, 1899. The Royal Electric Company has for many years been supplying the great bulk of the electric light and power service in Montreal, Canada, and has up to the present been utilising steam power for generating purposes. The company secured control of an immense water power situated at Chambly, on the Richelieu River, about fifteen miles from Montreal. It was found, after careful calculation, that the cost of water and steam power for the size of the plant necessary—8,000 H.P.—was almost equal, but that for any increase in size, the water power decreased at a much more rapid rate than did steam.

A contract was accordingly drawn up whereby the Chambly Manufacturing Company was to supply the Royal Electric Company with a specified amount of power in Montreal, with provision for increase, the steam plant remaining as at present for two years to provide for possible contingencies.

The hydraulic equipment of this plant has previously been fully described in the above journal, and this article deals solely with the electrical equipment. The generators, eight in number, were specially designed for this plant. Each is a 2,000-kw. two-phase inductor machine running at 153 r.p.m. and generating current at 12,000 volts directly at the machine at 66 cycles per second. Owing to the high voltage generated in the machine, all joints in the armature-coils are made with the greatest care. The joint after having been carefully soldered is covered with several layers of pure rubber tape, over which a composition of rubber and sulphur is placed, and covered all over with several layers of insulating tape. The joint is then soaked in boiling paraffin wax, which vulcanises the rubber, thus producing a joint such that there is no break in the complete insulation of the wire.

Such joints as these are made in connecting the armature coils together, and for all switchboard work. The base of one of these machines is a hollow rectangular casting, whose outside dimensions are 17 ft. 2 in. long by 10 ft. 11 in. wide and 25 inches thick, weighing no less than 100 tons. It is set on a concrete bed. Resting on this base is the armature, built up in two parts, an upper and a lower, bolted together in the middle. This armature is 15 feet in diameter and 6 ft. 6 in. wide. The coils are all machine wound, very carefully insulated, and intersect each other, the inner curving round the outer so as to be in quadrature. The single field coil, resting on the armature in a slot specially prepared for it, has slightly smaller diameter than the armature and is wound of bare copper strip insulated with japan and insulating linen. The joints in this strip are butted together and soldered with a special solder, thus producing a joint no thicker than a copper strip.

The inductor, built of laminated iron, and weighing 30 tons, is the only revolving element in the whole construction.

The air-gap between the inductor and armature is ½ inch. The field excitation is very small, being only ¾ of 1 per cent. of the total output of the machine. The shaft to which the spider containing the inductor is attached is 12 inches in diameter and is coupled directly to the turbines. Two exciters are provided, each of which is capable of fully exciting the complete installation.

From the alternators and exciters the cables pass through ducts in the concrete floor to the cable tunnel situated under the switchboard gallery. This cable tunnel has a vaulted roof, and is of sufficient height and width to allow free passage to several persons walking abreast. The cables, which are all lead-armoured, are placed on racks in the cable tunnel and are passed through ducts in the solid concrete to reach their respective places on the switchboard. The rubber insulation on all cables is $\frac{5}{32}$ inch thick, and they are tested to 40,000 volts. The switchboard is of marble and was tested up to 20,000 volts. The wooden framing was soaked in asbestos paint to make it fireproof and increase its insulation.

There are two sets of 'bus bars. These have a $\frac{5}{32}$ inch rubber insulation, with a thick jute outer covering. This was used instead of lead armouring on account of there being no possibility of a static charge collecting, as would be possible in the latter case.

The high-tension switches employed are of a novel type. As they appear on the switchboard there is only a small iron frame in which a long wooden lever may be turned through a 120 degree arc, and a small iron handle placed above. This latter is connected by means of a lever on the back of the switchboard to two valves, each placed in an air-duct into which air is pumped from a fan blower. These air-ducts are two wooden boxes running the entire length of the switchboard, and are situated so that when the valve is open a jet of air impinges on the contacts of the high-tension switch, thus destroying the arc. The iron handle directly above the high-tension switch cannot be opened until the valve in the air-duct is opened, thus always insuring an air-blast on the breaking contacts. Two 45-inch Sturtevant fans are employed for producing the air-blast. For the switch itself the moving lever on the face of the board is directly connected to a rocking lever, which moves a trolley to and fro containing the dead side of the switch. This trolley moves forward and engages with one set of contacts connected to the upper 'bus bars, or backwards to the lower 'bus bars, according as the lever is moved to the right or to the left of the centre. The contacts of the two sets of 'bus bars are 9 feet apart, and though the "off" position of the trolley is midway between the two, a break of 6 feet may be produced by moving the lever slightly past the centre. To prevent arcs from jumping from one switch to another they are separated by marble barriers 2 feet high. The ammeters and voltmeters on the switchboard are protected by glass cases.

Air-cooled transformers are employed for reducing the voltage to 500 volts—that required by the two-phase induction motors for driving the fans. The transmission lines will eventually consist of four 4-wire two-phase cables on two separate systems of poles. No fuses or circuit-breakers are used in the line, as the generators, on account of the great inductance of their armatures, will carry a short-circuit for a short time without any injury. The transmission wires of bare copper are placed 18 inches apart, and are carried on triple petticoat porcelain insulators tested to 40,000 volts. For protection against lightning three barbed wires are earthed at every pole, one being on the top of the pole, and the other two at the outer ends of the upper cross-arm ; all are mounted on glass insulators, these being used on account of the less liability to fracturing the barbed wire and thus producing a short-circuit, than when secured by ordinary staples. Lightning arresters and choke-coils are provided at four places on the line where it passes underground, as well as at the power house. At such points there are eight gaps between each line and the ground, each gap being for 2,000 volts. The line loss is about 10 per cent. at full load.

At the substation in Montreal the voltage is reduced to the city voltage of 2,300 volts by means of twenty-four 200-kw. single-phase transformers immersed in mineral oil and water cooled. Power and light are supplied from the same circuits, the slight regulation being performed by hand at the distributing board, the machines themselves having an inherent regulation of 10 per cent., between no load and full load. As each phase is independent in the two-phase system no method is needed to balance the loads on either phase, except that in order to obtain the full capacity of the machine each phase must be fully loaded. L. J. S.

1191. *Works of the King's County Electric Light Co., Brooklyn, N.Y.* (Elect. Rev. N.Y. 35. pp. 323–326, Nov. 22, 1899.)—This article deals fully with the coal-hoisting and conveying mechanism which handles the incoming fuel for the boilers ; and also with the arrangement of mechanical stokers and automatic ash hoppers. The present installation of generating units comprises four sets of 1,000 H.P. each and it is intended subsequently to install two other sets each of 2,000 H.P. The dynamos, direct-coupled to horizontal cross-compound engines, are of the three-phase type with stationary armatures. They are designed to operate at 93¾ r.p.m. and to give three-phase current at 25 cycles per second and 6,000 volts. The installation includes two direct-coupled exciter units. The arrangement of the switchboard is such that the operators in the station are nowhere brought into proximity with the high-tension circuits. The high-tension apparatus is installed in a cellar, and only the handles for manipulating the switches extend up into the main engine-room, the current-carrying parts all being on the floor below.

All the energy from the central station will be transformed either to direct current by the use of synchronous converters at substations, or rectified for arc lighting, or into mechanical energy and out again as some other form of current through synchronous-motor driven dynamos. The experiment of rectifier lighting is to be undertaken on a somewhat large scale by the King's County Company.

The situation of this corporation with regard to the electric-lighting industry of Brooklyn is such that all the present generating plants and all substations now in use may become centres of distribution for its central service.

The present plan for the distribution of electric current in Brooklyn is that the above-described station is to be the middle one of three along the East River and bay side of the borough of Brooklyn. The first of these stations is that at Bay Bridge, which feeds a large territory in the southern part of the borough. The new station, which is almost under the shadow of the Brooklyn Bridge, being situated a few hundred yards north of it, is intended to supply the central and populous districts of Brooklyn and Williamsburgh.

It is proposed to erect another large station at a point further north, which will supply the neighbouring districts. (See also 1899, Abstract No. 1796.)

L. J. S.

1192. *Transforming Station of the Buffalo General Electric Co.* (Amer. Electn. 12. pp. 59–67, Feb., 1900.)—The Niagara Cataract Power and Conduit Company delivers 3,000 H.P. three-phase current at 350 volts and 25 cycles per second to the central station of the Buffalo General Electric Co. This central station delivers four classes of service; namely, constant current for arc lights, 62 cycle alternating current for the incandescent lighting in the scattered districts, 500 volt direct current for motors, and 220 volt three-wire direct current for the local incandescent lighting. The station is unique in that there are no steam or hydraulic prime movers, all mechanical power being obtained from alternating current motors fed from Niagara.

The plant consists of fourteen 150-kw. induction motors driving twenty-eight 125-light arc machines; two 425-kw. induction motors driving single-phase alternating current generators, giving current at 62 cycles per second; one 425-kw. induction motor driving two direct-current generators, each 200-kw., 130 to 190 volts; two 200-kw. and two 100-kw. rotary converters; two 30-H.P. exciter sets; 150 Chloride (75 on each side) accumulator cells having a rated capacity of 3,000 amperes for a 1½-hour discharge rate.

The original apparatus for supplying the direct-current load consisted of two 100-kw. 125-volt rotary converters which were run in series with each other on their direct-current ends across the three-wire system. The machine is illustrated and attention is drawn to the fact that the commutator has practically the same length and diameter as the armature itself, this being due partly to the low voltage and also to the fact that a three-phase rotary converter can be made to deliver considerably more current without overheating than the same armature and fields would generate if mechanically driven as a dynamo.

A peculiarity of rotary converters for lighting service is the fact that the voltage of the direct current output is always exactly proportional to the alternating voltage on the collecting rings. If the latter varies due to changes of load and drop in the alternating current system the direct voltage varies with it, thus requiring as perfect regulation (so far as momentary changes of pressure are concerned) in the alternating system as is needed for the direct-current incandescent lighting. On this account and in spite of the greater cost and lower efficiency of motor generators as compared with equivalent rotaries, the additional transforming apparatus which has been installed is in the form of a motor generator in which the direct current is quite independent of the varying drop in the transmission line, and any sudden reactive drops in the transformers when alternating current motors are started. The motor generator has proved so very convenient that the Company is about to add a further unit consisting of two 400-kw. dynamos driven by a 900-kw. induction motor.

It may be mentioned that the regulation of the voltage of the rotary converters is partly effected by reactive coils, consisting of series windings on laminated iron cores, the three cores of the three phases forming mutual magnetic returns for each other. These coils introduce self-induction into the alternating current circuits, and such self-induction can be utilised by means of leading or lagging currents, to give a boosting or depressing effect upon the voltage, the leading and lagging currents being introduced by strengthening or weakening the field excitation of the machine. If the *field of the rotary is strong,* leading currents are drawn through the reactive coils and set up therein an inductive counter E.M.F. which on account of its phase relation adds to the original impressed E.M.F. If the *field of the rotary is weak,* lagging currents are drawn through the reactive coils and the inductive counter E.M.F. swings round so that it now opposes the impressed E.M.F. and so lowers the voltage. The result, so far as practical operation is concerned, is about the same as in the direct-current dynamo, *i.e.*, the field of the rotary is strengthened to increase the voltage and weakened to lower the voltage. By means of these reactive coils a range of pressure of about 12½ volts can be obtained.

The switchboard, which is fully described, is arranged for the rotaries, motor generators, and storage batteries being run in parallel. Detailed particulars are given of special swivel switches for the direct-current side of the rotaries; of a special field switch made in the hatchet form; and of the motor-driven-end-cell-regulating-switches for the Chloride accumulators.

The demand for energy throughout the twenty-four hours averages about 2,200 H.P. The battery carries the three-wire incandescent load during the evening without any help from the machines, the motor generator and the rotaries being shut down so as to reduce the load peak. During the day when the arc and incandescent load is very light the motor generator is run to carry the 220-volt load and charge the battery. As soon as the battery is charged the motor generator is shut down, the rotaries being then started up to carry the three-wire load. E. K. S.

1193. *Development of the Niagara Power System.* **J. E. Woodbridge.** (Amer. Electn. 12. pp. 1–20, Jan., 1900.)—The general design of the recently added alternators (there are now ten generating units each 5,000 H.P.) is the same as before, that is, an umbrella type of field rotating about an internal stationary armature. There are, however, some changes in detail with a view to the better dissipation of the heat, for although the machines have the extremely high efficiency of 98 per cent., the 2 per cent. wasted amounts to so much as 100 H.P. The spiders holding the two bearings are forced downwards by means of bolts into tapered seats, bored in the interior of the frame. The bearings themselves are also forced to a tight fit in the spiders, and are piped to an oil system, a screw pump lifting the oil to a reservoir placed under the eaves of the power house, from which it circulates by gravity through the bearings and down again to the pit. An oil recuperating system is provided consisting of tanks in which the oil is boiled and then filtered; the boiling is accomplished by means of electrical heaters, its purpose being to drive off any water that may become mixed with the oil.

To keep the bearings cool, holes are cored out which are connected with water-pipes. The frame has vertical ribs in which the armature laminations are dovetailed, and through these ribs run vertical passages which carry water for the purpose of cooling the armature core. Pipes connect the lower ends of these passages, while the upper ends are capped and connected together by means of small square cross passages cored in the casting.

The field cores are made up of bare copper strip wound edgewise, but differing somewhat from usual edgewise coils in that there are four layers. The four layers are separated from each other and rigidly held in place by means of metal spacing rods covered with mica and shellac insulation. Between these spacing rods there is ample room for the ventilation of each layer, circulation of air being permitted by means of ventilating openings in the casings. The edgewise turns of each layer are insulated from each other by strips of built-up mica and shellac insulation.

The new main turbine wheels are controlled by magnetic clutch governors designed by Coleman Sellers, in which centrifugal weights operate contacts in an oil bath, and these contacts close the circuits of electromagnetic clutches, one for the opening and the other for the closing motion of the gates. The alternators are shut down by simply opening the field circuit, the same action starting the governor into motion to shut off the water from the main wheels. Circuit-breakers in the field circuits of the machines are wired to an emergency switch, by closing which the fields of all the machines running in parallel with each other may be opened simultaneously in case of emergency, and the gates of the water-wheels of the same units may be at the same instant started towards the closed position.

A long and interesting account is given of the transmission of 15,000 H.P. to the works of the Union Carbide Co. Although the distance transmitted is only 11,000 feet it has been found worth while to step up from 2,200 volts two-phase to 11,000 volts three-phase, the transformers, six in number, being connected on the system introduced by C. F. Scott. The output of each transformer is 2,500 H.P.; they are made by the Westinghouse Co. and are oil insulated and water cooled. At the works of the Carbide Co. the voltage is reduced in two steps from 11,000 down to 110 volts, the first step by means of six units exactly similar to the step-up transformers, and the second step by means of ten 2,000 H.P. step-down transformers which have been supplied by the Wagner Co.

A number of interesting details are given of the construction of all the transformers, including those of the air-blast type supplied by the General Electric Co. Efficiency curves are given.

The heavy switching work in the Niagara power station is done by compressed air which is obtained from a water-driven Worthington pump. Most of the circuit-breakers are fitted with a time element device which has for its object to prevent a short-circuit at a point distant from the power house, opening any but the nearest circuit-breaker to it. Two methods by the Westinghouse Co. (Stillwell) and the General Electric Co. are described, as well as the *reverse current* circuit-breaker mechanism as used on the Niagara-Buffalo transmission line.

Particulars are given of a special Westinghouse 450-kw. transformer giving 37,500 amperes at 12 volts. The transformer has a single secondary turn and the pressure is regulated from 12 to 30 volts by changing the number of turns on the primary side.

On the Niagara-Buffalo transmission line the voltage is 11,000 and the wires are arranged triangularly 3 feet apart and spiralled at intervals. The maximum load at this voltage is about 10,000 H.P., so that in order to allow for the expected increase of load it is proposed to raise the line pressure to 22,000 volts besides erecting another pole line to Tonawanda. The guard wires which were intended to serve as lightning arresters have been taken down, as the trouble they caused through falling proved greater than any probable benefits. Lightning arresters are in use at the transmitting end, and also at the Tonawanda substation and at Buffalo where the line goes underground.

The article closes with an account of the work of the Cataract Power and Conduit Co. which assumes control over the transmission line where it enters the Buffalo City limits and handles the power from that point to consumers' premises. A number of interesting particulars are given of the various underground cables and of the substations. Amongst customers for power are the Buffalo General Electric Co., 3,000 H.P.; the International Traction Co., 5,000 H.P.; a large grain elevator, 1,000 H.P.; whilst the Union Dry Dock Co. operates its extensive workshops, &c., entirely by means of induction motors, practically every machine, tool, elevator, crane, &c., having its own motor belted to it. E. K. S.

1194. *Detroit, Ann Arbor Interurban Railway.* (Street Rly. Rev. 10. pp. 5–8, Jan., 1900.)—The Detroit, Ypsilanti and Ann Arbor Electric Railway has 50 miles of track and runs 20 cars, each equipped with double trucks and four 50-H.P. motors. Each car is provided with a series of multiple controllers for operating the motors in combinations of pairs in parallel-series, or all motors in parallel. Three Westinghouse 225-kw. direct-current generators at 250 r.p.m., and 575 volts are connected by flexible couplings to 450-H.P. engines. Motor-driven boosters of 135 and 125 kw. are driven off the 'bus bars and operate in series with the feeders, whose voltage they raise to 900 volts. E. H. C.-H.

1195. *Interurban Tramways, Buffalo, N.Y.* (Street Rly. Rev. 9. pp. 815–822, 1899.)—The International Traction Company now owns almost all the lines around Buffalo and Niagara Falls. It operates the Buffalo city cars, equivalent to 5,000 E.H.P. on the average, from the 11,000-volt transmission line from Niagara, which is brought direct to five stations. At these stations a novel type of fuse is used; when the main line opens it is short-circuited through an explosive fuse provided with tubes which lead the gases away and blow out the arc. By clockwork and a battery it is so arranged that the overload must be on the station 3½ seconds before it will operate the station fuse. In three stations the 400-kw. converters are started by direct current; in the other two by a 30-kw. induction motor, with independent transformers, coupled to a 25-kw. direct-current generator. The armatures of the rotaries are given a shuttle movement by an electromagnet and an intermittent current, thereby securing uniform wear.

Cast-welded joints, to the number of 11,000, were made last year by the Lorain Steel Company. Also, around all special work, copper cables have been provided and welded in place, thus permitting easy removal for repairs without interfering with the return circuit. The operations in cast-welding are fully described. E. H. C.-H.

1196. *Detroit, Port Huron Interurban Railway.* (Street Rly. Journ. 16. pp. 119–124, Feb., 1900.)—The Rapid Railway Company of Detroit, Mich., the pioneer high-speed railway, used to run over 20 miles of track at 25 miles per hour using the direct-current system throughout. It is now about to operate a route of 73 miles to Port Huron from one main half-way power house at Baltimore. Cedar sleepers, gravel or stone ballast, 70-lb. rails, and "Crown" bonds are being used. The power house contains four 300-H.P. Babcock and Wilcox water-tube boilers with "Roney" stokers, the draught being produced by two slow-speed, up-discharge, direct-connected steam fans, which deliver into a short stack 7 feet in diameter reaching only a few feet above the roof. There are three main engines of the Westinghouse vertical tandem type, cylinders 21½ inches and 37 inches by 22 inches stroke, giving 1,000 H.P. each at 214 r.p.m. These are connected direct to three 500-kw. Westinghouse engine-type three-phase generators, giving 750 amperes per phase at 375 volts and "3,440 alternations." To drive the alternators in parallel with fluctuating loads, the engines are provided with apparatus by which the speed of any one can be varied at will from the switchboard. There are also two steam exciters at 125 volts. All the engines exhaust into one Worthington jet "dry-air pump" condenser. Compressed air is provided for cleaning out the electrical machinery. There will be five rotary substations where the 16,500-volt current will be stepped-down and then converted by rotaries into direct current. One set of poles serves for the high-tension transmission line, the low-tension feeders, and the bracket arms for the trolley wire. "Locke" porcelain insulators are used on the high-tension lines. The new 50-feet cars each have two 75-H.P. motors. The schedule time including stops will be 27 miles per hour, with a speed of 45 miles per hour between stations. Freight traffic will be handled by Baldwin-Westinghouse electric locomotives. The electric cars take 50 per cent. of the local traffic in fruit, fish, meat, &c. (See also 1899, Abstract No. 1097.) E. H. C.-H.

1197. *Track Construction in Buffalo.* (Street Rly. Rev. 10. pp. 26–27, Jan., 1900.)—Where ordinary stone paving is used between tracks, and the same or asphalte outside, "trench" construction is used. Longitudinal trenches are dug 17 inches deep and shovel-width at the bottom, with cross trenches alternately 17 and 20 inches deep at 5-feet centres. Hard oak ties, 5 × 7 inches × 7 feet are then put in the cross trenches, the rails spiked on to them and gauged, and held temporarily by fishplates. The track is surfaced and the ties in the shallow trenches tamped with dry stone. Concrete is then run into the deeper cross trenches and into the longitudinal trenches, and after 72 hours the fishplates are removed and the joints cast-welded. Pounded sand is then laid between trenches as a base for the common stone paving. Where asphalte is used outside the rails, toothing stones are set outside them. For first-class granite sett paving, the ground is excavated 7 ft. 8 in. wide and 15 inches deep with cross trenches 5 inches deeper for the ties, which are set in concrete. After alignment, the whole is run in with concrete and covered with 4 inches of gravel to receive the setts.

E. H. C.-H.

1198. *The Electric Tramway and its Future.* **J. Swinburne.** (Feilden, 2. pp. 125–133, Feb., 1900.)—The most serious and obscure problem in connection with electric tramways is the earth return. The common idea that electrolysis cannot occur unless the pressure is sufficient to decompose water is erroneous. The effects of electrolysis are cumulative. Insulated return feeders give the only satisfactory solution. In order to keep the rails at zero potential it is only necessary to insure that there is the same loss in all the feeders, which can be secured by adjustable resistances in each feeder, or by auxiliary dynamos therein.

The author suggests (though he has not worked out the cost) that each car might carry an alternating motor running at a uniform speed, whether the car is at rest or in motion. This motor would be coupled to a direct-current generator which would then drive the usual tramway motor. The system would obviate difficulties with long-distance transmission or earth return, and would permit easy speed regulation by varying the field of the generator.

The accumulator system is likely to become of more importance, as improvements in batteries decrease their dead weight. Vibration is the greatest enemy of a cell. Not only must the coating of a plate stay in place: it must also remain in electrical contact with its support. Laboratory tests are therefore of small value, because high capacity and discharge rates can be easily obtained at the expense of durability.

In the future of tramways the author considers oil or steam will play an important part. Recent developments in steam vans make it probable that steam will have another innings on tramways, especially for distances where difficulties arise in electrical transmission. One necessity for good locomotion is uniform speed: cart-horses are the chief obstructions in streets. The abolition or reduction of horses, coupled with smooth non-hammering wheels, means good smooth roads, easily kept in repair. If we have hard and smooth streets and successful automobiles, then the need for tramways, electrically worked or otherwise, is gone. England is starting electric trams ten years after other people, with the result that we have the advantage of others' experiences; but we also start with a system which is ten years nearer its death. In ten years' time the motor 'bus may have ousted the electric tramway with its capital cost and its inflexible system. E. H. C.-H.

1199. *Columbia Electric Automobiles.* (Elect. World and Engineer, 35. pp. 53–56, Jan. 13, 1900.)—This article describes the construction of the electrical vehicles manufactured by the Columbia Company, of Hartford, Conn. The special features are a flexible frame, wooden wheels, and a general lightness of design. Cars with both one and two motors, driving the rear wheels through double-reduction gearing, are described. Either solid rubber or pneumatic tyres are fitted, and it is stated that there is a useful field for both types. From 40 to 44 accumulator cells are employed for each car; these are manufactured by the Electric Storage Battery Co., of Philadelphia. The speed controls are obtained on some carriages by battery commutation alone; on others by series-multiple motor arrangements also. The vehicle equipments vary from one with a 700-lb. battery, 140-lb. motor, 8¾ to 1 reduction gearing and motor current of 20 amperes at 75 volts, to one with a 1,390-lb. battery, 310-lb. motor, 13 to 1 reduction gearing, and motor current of 40 amperes at 75 volts. Several designs for the rear axle arrangements are described and illustrated. (See also 1900, Abstract No. 768.) A. G. N.

1200. *Goldschmidt's Rail-Welding Process.* **Goldschmidt.** (Street Rly. Journ. 16. p. 158, Feb., 1900); and **Beyer** (Street Rly. Journ. 16. pp. 158–159, Feb., 1900.)—This process permits the rapid production of molten iron in a crucible without a cupola. Powdered aluminium is mixed with powdered oxide of iron and is ignited, when the latter supplies the excess of oxygen necessary to support the combustion of aluminium, which forms liquid aluminium oxide, or "corundum," and reduces the iron oxide to molten iron. A sheet-iron mould is placed around the joint to be welded and is packed with stones and sand. The mixed powder of aluminium, &c., is ignited by a special fuse, consisting of a small ball of superoxide of barium and aluminium, which is itself ignited by burning magnesium ribbon. The aluminium oxide rises to the top of the crucible, and when poured enters the mould first, forming a thin protecting coating on the sheet iron and sides of the rail. A layer of corundum also forms on the inside of the crucible as a fireproof glaze, which preserves the heat of the molten metal to such an extent that the workmen can handle the crucible without trouble.

Beyer added to the above description given by Dr. Goldschmidt to the Verein Deutscher Strassen und Kleinbahn Verwaltungen, some notes on the effect of temperature on cast-welded joints. He experimented on a 7-inch girder rail, having a cross-section of 52 sq. cm., and a tensile strength of 6,000 kg. per sq. cm. The modulus of elasticity which would theoretically double the length of an iron rod 1 sq. cm. in section is 2,000,000 kg. cm. Therefore for a range of 60° Celsius, which he considers the maximum in Germany, the force, considering iron to expand 0·1079 per cent. for each 100° Cels., is 67,330 kg., so that the factor of safety in this case is 4·6. He claims that the temperature of the welding may be so chosen that the ends of the rails are not actually melted, thus preventing any change in the structure of the material. E. H. C.-H.

1201. *Cost of Arc Lighting.* **H. H. Wait.** (Amer. Inst. Elect. Engin., Trans. 16. pp. 579–604, Nov., 1899.)—Tables are given in this paper showing the comparative first cost and operating expenses of various arc-lighting systems, on an equitable basis. The author refers to a recent article by W. L. Robb (see 1900, Abstract No. 955) on the Hartford system of arc lighting, where it was stated that the changes in the Hartford plant would pay for themselves in about two years. From the tables in the present article it would appear that in some cases the more modern continuous-current systems might replace older ones and pay for the changes in still less than two years. The question is so dependent on local conditions, however, that it is impossible to make any general statements.

The vital question in comparing alternating and direct-current systems is the relative amount of power consumed for the same amount of light. In compiling the tables the different types of lamps have been given the following ratings for the sake of comparison :—

Direct-current open arc—450 watts at arc	2,000 c.p.
„ „ enclosed arc—450 watts at arc ...	1,500 „
Alternate-current enclosed arc—450 watts at arc	1,150 „
„ „ enclosed arc—400 watts at arc	950 „
Direct-current open arc—300 watts at arc	1,200 „
Direct-current enclosed arc—300 watts at arc ...	900 „

To arrive at an equitable figure for comparing the direct-current open and enclosed arcs, it was assumed that the ratio of watts per mean spherical c.p. in the open arc to those in the enclosed arc is 75 per cent. This figure is practically a mean of the results obtained by Elihu Thomson, L. B. Marks, Pierron, and W. O. Steel. It was further assumed that the excess of watts per mean spherical c.p. for alternate-current over direct-current arcs is 33⅓, which is practically a mean of the results obtained by Matthews, L. B. Marks, Elihu Thomson, W. O. Steel, and the Western Electric Co. In the table of costs, the resulting costs have been divided by the nominal candle-powers so that the cost can be compared readily at any reasonable rating. The tables are all made on the assumption that the arc lighting part of the plant is running at very nearly full load whenever it does run. This will, of course, not apply to commercial lighting circuits, and considerable corrections will have to be made for such conditions.

A point in favour of the alternating systems is the fact that the position of the plant or other local conditions may permit a saving in the line investment for example, where a large number of circuits have to be run for a long distance in the same street, a saving in the investment could probably be made by the alternating system by the use of a substation at the point of distribution. In cases where there is already a greater generator capacity installed than is actually needed, it is, of course, possible to leave out a considerable portion of the investment shown in the tables. In rare cases, the peak of the commercial lighting and power load would not overlap the arc-lighting load, and under such circumstances, some of the transformer systems, either direct or alternating current would have a great advantage.

Curves are given in this paper showing the luminous intensity at street surface with different lamps. In general it will be seen that the direct-current plants are the most favourable for places where the whole or nearly all the output is used for arc lighting—where but a small portion of the load is arc lighting, either the simple alternating systems or some of the systems transforming into direct continuous current by means of motor generators or rectifiers would be most practicable.

Comparative Cost per Arc Lamp per Year of 3,800 Hours with Different Systems.

No.	System.	Total cost per lamp in $.	I.H.P. per lamp.	Total operating expenses in $.
1	Hartford, 400 watts enclosed	146·50	0·744	52·86
2	Hartford, 450 watts enclosed	155·24	0·822	57·85
3	Alternate-current Ind. Reg., 400 watts enclosed	139·80	0·708	50·75
4	Direct-current arc driven by alternate-current motors, 300 watts enclosed...	131·42	0·630	46·03
5	Direct-current belted, 300 watts enclosed............	117·90	0·552	41·75
6	Direct-current arc, driven by direct-current motors, 300 watts enclosed	129·45	0·642	46·06
7	Direct-current arc belted, 450 watts enclosed	147·37	0·830	57·07
8	Direct-current arc belted, 450 watts open arc	142·60	0·832	68·53
9	Direct-current arc direct driven, 450 watts open direct current	142·00	0·810	62·58
10	Alternate-current Ind. Reg., 450 watts enclosed. No increase in generating plant	91·14	0·804	45·89
11	Direct-current arc driven by alternate-current motors, 450 watts enclosed. No increase in generating plant	100·40	0·948	53·93
12	Rectifier system, 450 watts enclosed ...	154·30	0·816	53·69
13	Incandescent, 3–50 c.p. lamps, 450 watts	121·75	0·766	60·85

L. J. S.

1202. *Lighting by Alternate-Current Arc and Incandescent Lamps.* **R. Fleming.** (Elect. World and Engineer, 35. pp. 133–134. Discussion, pp. 134–135, Jan. 27, 1900. Paper read before the Eighth Annual Convention of the North-Western Electrical Association.)—The author advocates the use, as a system, of alternating-current enclosed arc lamps with constant current transformers and estimates that a saving of $8—$12 per lamp per year can be made over direct-current open arc lamps. In the discussion, the speakers confirmed the author's opinions, and some favourable results were quoted of working with 32-c.p. incandescent lamps in series. These lamps have a life of 4,000 to 5,000 hours. The most satisfactory size of enclosed arc is a lamp consuming from 425–440 watts at 6·6 amperes and 70–75 volts at the arc.

C. K. F.

1203. *Arc Lighting without Regulating Resistance.* **X. Gosselin.** (Soc. Int. Élect., Bull. 16. pp. 443–450; Discussion, pp. 450–467, 1899, and 17. pp. 100–106, Feb., 1900.)—In order to prevent undue variation of current, arc lamps are connected in series with a steady resistance in which 20 to 30 per cent. of the power is lost. To economise this power automatic devices may be employed which introduce a resistance only when the current exceeds the normal value. Three arc lamps can then be run in series across the 110-volt mains. Such lamps designed by Hegner, Vigreux, and Brillé are described.

In the discussion **Aliamet** pointed out that with alternating currents this economy may be effected with only two arcs in series by replacing the steadying resistance by a choking coil. Low voltage arcs are very short compared to those of normal voltage and give a correspondingly bad distribution of light, also the carbons are liable to fuse together instead of striking owing to sluggishness in the automatic regulator. With two arcs in series the extra resistance required can be obtained by reducing the section of the leads, thus effecting a saving in copper. **Hegner** pointed out the effect of the presence of mineral salts in the carbons in allowing a longer arc with reduced voltage, and described his lamp in detail.

L. B.

1204. *Lighting from Primary Batteries.* **F. E. Woodford.** (Amer. Electn. 12. pp. 92–94, Feb., 1900.)—The author proposes to use gravity cells, capable of giving half an ampere continuously for two months without attention, permanently connected in parallel with a battery of storage cells. When light is not required, the latter are automatically charged by the gravity cells which are in this way kept in good condition. An estimate is given for outlay, but the author does not go into the question of cost of running.

W. R. C.

1205. *Candle-Power of Arc Lamps.* **E. P. Warner.** (Elect. World and Engineer, 35. p. 66, Jan. 13, 1900. Paper read before the December meeting of the Chicago Electrical Association.)—This paper deals with the relative candle-power of direct and alternating enclosed arc lamps. It is illustrated with a diagram of two curves of photometric readings at different angles taken from two lamps with all conditions alike except that one was direct and the other alternating. There is a remarkable similarity in the distribution of light in the two, but the direct current exceeds the alternating current in light capacity by an average of about 12 per cent.

In order to correct the violet rays in the alternating lamp the author has used what is known as an alabaster globe. This is composed of two layers or thicknesses of glass, one of which is clear or slightly tinted with uranium, and the other opalescent. This acts on the violet rays somewhat similarly to a solution of quinine sulphate, and transforms the violet into white light, with, however, a material loss of light.

E. C. R.

1206. *Life Tests of Glow-Lamps.* **G. D. Shepardson.** (Amer. Electn. 12. pp. 76–77, Feb., 1900. Abstract of a paper read before the Northwestern Electrical Association.)—This paper deals with tests made on the candle-power and watts taken of batches of lamps rated at 16 c.p., and picked at random from the stocks of several American lighting companies. The lamps were first tested with an average result (for 55 lamps) of 18·3 c.p. and 55·8 watts, or 3·1 watts per candle. The initial candle-power varied from 14·1 to 23 and the watts from 47·3 to 71·3, or from 2·32 to 4·10 per candle. These lamps were all tested at their marked voltages. Lamps were then selected at random from the different lots obtained from the various sources, and were maintained continuously at the constant voltage they were marked for, tests being made every 24 hours. After 50 hours burning the candle-power varied from 8·2 to 23, the watts per candle from 2·32 to 4·1, the average being 17·5 c.p. and 3·27 watts per c.p.

After 100 hours the figures were from 10·1 to 22·3 c.p. and from 2·52 to 5·02 watts per c.p., the averages being 17.5 c.p. and 3·3 watts per c.p.; after 400 hours from 11·3 to 19 c.p. and from 3·00 to 4·31 watts per c.p., the averages being 16·0 c.p. and 3·54 watts per c.p.; after 600 hours 11·4 to 18·8 c.p. and 3·34 to 4·26 watts per c.p., the averages being 14·7 c.p. and 3·82 watts per c.p. A few lamps were burned from 800 to 900 hours, at which time the c.p. varied from 10·8 to 16·4, and the watts per c.p. from 3·6 to 4·4. Early in the test several of the lamps "burned blue," and their high efficiency pointed to short life. All of the lamps in one group had burned out in about 100 hours, whereas some of those in another group lasted 500 hours. Experiments were also tried on the behaviour of lamps on a circuit varying from 104 to 118 volts.

E. C. R.

REFERENCES.

1207. *Electrical Cabs in New York.* **G. Pellissier.** (Écl. Électr. 22. pp. 41–50, Jan. 13, and 88–92, Jan. 20, 1900.)—Two articles with several drawings showing design of the cabs, and also illustrating the method of charging the accumulators.

1208. *Automobiles for Transport.* **Bricka.** (Écl. Électr. 21. pp. 424–425, 1899.)—The author tabulates the relative cost per ton kilometre with transport by mules, carriages, and automobiles. M. O'G.

1209. *Incandescent Lamps.* **G. Richard.** (Écl. Électr. 19. pp. 321–325, 1899; 22. pp. 206–212, Feb. 10, 1900.)—Description of Nernst, Phelps, H. and F. Angenault, Thomson-Houston, Lister, Wierre, Renous and Bronilawski lamps; Adams' mining lamp, and Stearn's method of manufacturing filaments (pp. 321–325). Methods of manufacturing incandescent lamps; some useful drawings are given (pp. 206–212).

1210. *Nernst Lamps.* (Écl. Électr. 22. pp. 142–144, Jan. 27, 1900.)—Description of patents by R. A. Fessenden in connection with contacts and methods of automatic lighting. W. R. C.

1211. *Battery Regulation.* (Elekt. Runds. 17. p. 104, Feb. 15, 1900.)—A description of the method employed by the Cie. de l'Industrie Electrique, in which a charging and discharging booster connected in series with the cells replaces the usual battery regulating switch. L. B.

1212. *Ingleton Central Station.* (Electrician, 44. pp. 578–583, Feb. 16, 1900.)—A description with illustrations and drawings. The dynamos are driven by water power, there being a fall of 27 feet available.

1213. *Incandescent Lamps.* **H. Remané.** (Zeitschr. Instrumentenk., Beib. 23. pp. 209–213; 24. pp. 221–227, 1899. Report read before the Zweigverein Berlin der D. G. f. M. ŭ. O., November 7 and 21, 1899.)—This paper comprises a short history of the development of the incandescent lamp, a description of its manufacture as now practised and of its physical properties, and a list of the various uses to which incandescent lamps are applied. C. K. F.

1214. *Philadelphia Electric Company.* **C. W. Swoope.** (Elect. World and Engineer, 35. pp. 279–281, Feb. 24, 1900.)—A description of the central distributing station, which contains large biphase machines.

1215. *Polyphase Transmission.* **C. F. Scott.** (Journal of Electricity, S.F. 8. pp. 121–128, 1899. Paper read before the National Electric Light Association, March 1, 1894..)—An exposition of the general principles involved.

1216. *Peoria and Pekin Railway, U.S.A.* (Street Rly. Journ. 16. pp. 134–141, Feb., 1900.)—This is an instance of a railway worked both by steam and electricity. It is ten miles in length; a general description of its equipment is given.

1217. *Rail-Welding Train.* (Street Rly. Rev. 9. pp. 823–825, 1899.)—An illustrated description of the cupola car, the sand-blast car, the heater car, and the supply car, which together form the train used for cast-welding operations by the Calumet Street Railway Company, Chicago. E. H. C.-H.

1218. *Trolley Wires over Movable Bridges.* (Elect. Engin. 25. pp. 186–187, Feb. 9, 1900.)—The article gives particulars of the methods adopted for carrying the trolley wire over a movable bridge at Hull. Three drawings are given.

1219. *Drying Traction Motors.* (Street Rly. Journ. 16. p. 146, Feb., 1900.)—A short paragraph stating that in snowy or wet weather the Albany Railway Company adopts the plan of drying their motors in the car sheds. For this purpose they have 1¼ inch steam-pipes, placed parallel to and between the rails, and about 3 inches below the motors on the cars. Live steam is kept in these pipes through the night. This method has materially reduced the repair bill.

1220. *American Automobiles.* **F. B. Rae** and others. (Elect. World and Engineer, 35. pp. 92–95, Jan. 20; 129–130, Jan. 27; p. 173, Feb. 3, 1900.)

1221. *German Automobiles.* (Elect. World and Engineer, 35. pp. 207–209, Feb. 10, 1900.)—An article, illustrated by photographs, dealing with some modern designs.

1222. *Tramways in Berlin.* **D. B. Macgowan.** (Tram. Rly. World, 9. pp. 15–17, Jan., 1900, from the Chicago Tribune.)—A general statement as to the various tramways either projected or under construction. The tramways are operated in general on the mixed system, *i.e.*, trolley-wire system in the outskirts, and accumulators in the centre of the town, the accumulators being charged while the cars are on the trolley-wire section. The City gets 8 per cent. of the gross receipts in the case of the two largest companies; and whenever dividends exceed 12 per cent. one-half of the excess goes to the City.

1223. *Economy in Power-Stations.* **M. Hoopes.** (Elect. Rev. N.Y., 35. pp. 226 and 243, 1899.)

TELEGRAPHY AND TELEPHONY.

1224. *Submarine Cable Signals.* **A. Jamieson.** (Inst. Engin. and Shipbuilders, Trans. 43. pp. 34–45, Feb. Discussion, pp. 33–41, March, and pp. 17–20, April, 1900; also Electrician, 44. p. 789, March 23, 1900.)—The Cape Town shore-end of the main cable to Mossamedes passes round the south-eastern curve of Table Bay. Electric tramway trolley lines are suspended overhead from Wynberg to Cape Town, almost parallel to the cable, at a mean distance of about half a mile from the shore-end. The condition of affairs is further complicated by subterranean lines running close to the tramway rails. To check the disturbing effect of the tramway circuit upon the signals, a cable of about 5 n.ms. was laid as nearly as possible over the shore-end of the main cable, and connected to the earth side of the recorder, the sea end being earthed to its own sheathing. This device resulted in improved signals. But an extension of the tramway rendered it necessary to lengthen the subsidiary cable to 11 n.ms. It is now suggested to adopt the Hughes' method, using a twin twisted core, with double armouring. Further it is recommended that the tramway company should adopt a sufficient number of boosters to reduce the return currents in the rails. R. A.

1225. *Duplex Telegraphy in Belgium.* **Buels.** (Soc. Belge Élect., Bull. 17. pp. 68–80. Discussion, pp. 80–87, Feb., 1900.)—An explanation is given of the means adopted to balance the capacity and self-induction of the line circuit upon the differential duplex. It is observed that these phenomena, while producing opposite effects upon the relay in circuit at a sending station, do not by any means compensate each other. Want of balance as regards these qualities in the artificial line gives "kicks" of different senses in the instrument. The means of entirely relieving the relay (English P.O. standard) of disturbances when the sending key is operated have been studied, and the results are that the artificial line is composed of two electromagnets, horseshoe form, having each a resistance of 500 ohms, with movable cores by which the inductance can be regulated. Between these is a non-inductive resistance to balance the rest of the non-variable line resistance. The condensers were attached to this and can be adjusted at will by ordinary methods. A condenser of small capacity (½ to 1½ m.f.) is also permanently attached to the extremity of the artificial line nearest the relay. The English P.O. relay is found to be very sensitive for indicating balance, and as the Hughes apparatus is used on the Belgian duplex circuits this is of great importance. A slight want of balance does not affect Morse instruments in their functions, but absolute compensation is required with the Hughes to prevent distortion of signals. It is also necessary that they should be quite detached one from another, and to this end the real and artificial lines are joined in shunt across the relay by a resistance having strong self-induction, which acts to quickly restore the armature of the relay upon the cessation of a signal. This is the device of M. J. Pierart. E. O. W.

1226. *Contact Force of Metals used for Working Telephones.* **E. Piérard.** (Soc. Belge Élect., Bull. 17. pp. 88–93, Feb., 1900.)—A "vibrator" or periodic interrupter, consisting of a metallic disc fixed as in a Bell telephone receiver, with a platinised point suitably placed behind its centre, but not quite touching it, the disc and point being joined respectively to the two-line wires, will transmit musical notes to a distant receiver, the electromotive force arising from the contact of the disc and the point where the former is pressed inward upon the latter. It is, of course, only upon closing such a circuit that an impulse is transmitted and consequently fundamental sounds are reproduced and harmonics excluded. By interposing an induction coil in the usual way the sounds in the receiver were magnified. It might be supposed that the effect was voltaic or thermic, or perhaps both, since the breath may cause a difference of temperature. The author examines this question, firstly trying discs of various metals and alloys. Some were successful, and with some no sound was obtained ; but in all cases but one, if a little disc of platinum was soldered to the back centre of the large disc so as to come into contact with the point when the movement occurred, the force was present and sounds heard with more distinctness in all cases. The temperature was next kept constant and, instead of applying the mouth to the "vibrator" it was caused to move by the beat of a wooden drumstick, when the sounds were found to be reproduced. Again, if a copper-toothed wheel turning upon an axle of iron is introduced into the circuit in place of the vibrator and one end of the copper wire of the primary caused to make intermittent contact with the teeth while the other end touches the copper nave, no sound is heard. But if the second wire is removed from the nave and is caused to touch the iron axle, all the interruptions are heard in the receiver. The author concludes then that the effect is not thermoelectric, but due to both the contact of dissimilar metals where such are employed, and to the states of their surfaces being different. E. O. W.

1227. *Telephone Exchange : St. Louis, U.S.A., Kinloch Tel. Co.* **F. E. Bausch.** (Elect. World and Engineer, 35. pp. 5–10, Jan. 6, 1900.)—Full description with illustrations of the St. Louis "independent" telephone exchange. All subscribers are brought to one exchange in which is a Kellogg divided multiple switchboard. The switchboard is in four parts, A, B, C, and D. Each division consists of ten sections. Each section is fitted with multiple jacks for one-fourth of the lines entering the exchange. An indicator and an answering jack for every line appear in each of the four divisions. The equipment is for 8,800 lines ; thus each section has 880 indicators and 880 incoming call (or answering) jacks. Each subscriber's station is equipped with a magneto generator and four keys with commutator springs and connections for operating any one of four indicators at the exchange switchboard. The keys are designated A, B, C, and D respectively and correspond with the four divisions of the switchboard. The commutator springs and connections of the keys permit the selection for operation (method described) of one out of the four indicators attached to each line. The subscribers are designated A1, B1, C1, D1, &c. Any subscriber requiring a subscriber in class D presses key D and rings ; his indicator will fall in division D of switchboard, where all D subscribers are multipled, when the connection is completed in the ordinary way. The clearing-out signal is operated by depressing any one of the four keys at the subscriber's station. It is stated that automatic calling and clearing will be installed this year. J. E. K.

1228. *Selective Telephone Signals.* **H. S. Webb.** (Amer. Electn. 12. pp. 94–97, Feb., 1900.)—The author describes a new selective signalling system for any number of telephone offices up to eight, upon one and the same circuit, by J. A. Barrett. In the subscriber's office, relays, local battery, and ordinary vibrating bell are dispensed with, and a single polarised bell having one or two windings on each of its cores is substituted. In the Exchange there is a key for each subscriber, which is so connected that a current of the right sign and direction is sent from a universal battery, automatically making and breaking circuit, by one or other conductor, with earth on or off, or by both conductors simultaneously with earth on, either by the metallic loop, or to earth at the subscriber's office. There are thus eight different sorts of circuits, in each of which only the polarised bell in the office wanted is rung and the bells in the other offices, owing to the peculiar winding of the cores, are left unaffected. Should it be required to use an ordinary alternating current generator for ringing purposes the arrangement described will suit for four offices upon one circuit. It is found more satisfactory to call by a direct continuous current from the Exchange and to have an interrupting device which shall vibrate the bell armature in the subscriber's office. In this view, at the latter, the bell apparatus is provided with a normally open shunt circuit and a vibrating circuit changer is operated by the movements of the armature, the coil circuit being thus opened and closed in the usual way. E. O. W.

1229. *Disturbances on Telephone Lines.* **E. Piérard.** (Soc. Belge Élect., Bull. 16. pp. 35–44. Discussion, pp. 44–45, 1899.)—Depauw noticed that crackling noises occur when a metallic circuit has a fault to earth, and is on the same posts as telegraph wires. If there are no telegraph wires no noises occur, and if the circuit is of limited length as in local telephones an earth does not result in a serious noise. The audible telephone current being half a microampere, the line must be 10 km. long to be affected by telluric currents (taking ten posts per km. and allowing each to have a resistance, wet, of 10 megohms). Noises due to the electromotive force at the earth contact are mainly due to the charge and discharge of the line capacity. The author concludes that telegraph wires, as such, have nothing to do with the noises. **Depauw,** in discussion, said that the telephone line from Furness to Ostend, which has no telegraphs on the same supports, gave no crackling noises on being earthed. This is contrary to the German example on a 325 km. line quoted by the author. **T. Piérart** said the Ostend line was too short to be compared to the other. M. O'G.

REFERENCES.

1230. *Telephone Cables.* **F. C. Cosby.** (Elect. World and Engineer, 35. pp. 10–13, Jan. 6, 1900.)—Description of cables and terminals used by Kinloch Telephone Company, St. Louis, U.S.A., with particulars of the method of laying and connecting. J. E. K.

1231. *New Military Telephone.* **J. P. Wisser.** (Elect. Rev. N.Y. 36. p. 5, Jan. 3, 1900.)—This paper contains a description of Siemens and Halske's combined telephone and telegraph for field use. J. B. H.